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ON SOME RECENT TEXT-BOOKS OF ANATOMY, WITH SPECIAL REFERENCE TO THE NEW AMERICAN EDITION OF GRAY.[1]

BY FRANKLIN P. MALL.

Judging by the numerous text-books of anatomy which have been published during the past century, it is quite clear that the authors have attempted to give the essentials of the subject, from one standpoint or another, for students of anatomy who are beginning the study of medicine. The book selected by the student usually makes a lasting impression upon him and in later years he frequently uses it for reference; for this reason it should be extensive enough to lead him into the literature upon the subject whenever it is demanded by special circumstances. Fortunately, during this period there has been a classic anatomy (Quain) in the English language, which has passed through numerous editions, having been revised successively by the greatest anatomists of England. This great work has guided many of our best students in their work, and has been made available to European students through numerous translations. However, the majority of students prefer a work which is more compact and treats the subject from a more practical standpoint, that is, aids them to study anatomy in the laboratory, emphasizing especially those portions which bear directly upon practical surgery for the time being, leaving their own future development pretty well out of consideration.

Gray's anatomy fulfills this last requirement admirably. The first edition, which appeared in 1858, is a compact work well written and well illustrated from the standpoint of descriptive anatomy and its application to practical surgery. It immediately gained favor in England and in America, and with us has been viewed as a second Galen to which nothing could be added nor taken away, a view which hinders much the progress of any subject. New editions of the work rapidly followed one another, but in general they were revised but little for some 35 years, and on account of the very extensive use of the book by students, teachers, and examiners, it gained a position which made it heresy to question either its authority or its infallibility.

In looking over an old edition of Gray (1862) one is struck with the completeness and accuracy of the work to fit the knowledge of that time. For instance, the articles for the spleen and liver are excellent, being based upon the great works of Gray and Kiernan. Those upon the lung and in-

[1] Anatomy, Descriptive and Surgical. By Henry Gray, F. R. S. Edited by T. Pickering Pick, F. R. C. S., and Robert Howden, M. A., M. B., C. M. New American edition. Thoroughly revised and re-edited with additions by John Chalmers Da Costa, M. D., illustrated with 1132 elaborate engravings. (Philadelphia and New York: Lea Brothers & Co., 1905.)

testine, however, are meager in the light of our present knowledge of these organs. One reads there that "the villi are highly vascular structures covered with cylindrical epithelium and said to contain muscle which may aid in the propulsion of food." In the course of time Watney's work served as a basis for a revision of this statement. So until the 13th edition appeared we notice occasional changes here and there in the American edition; sometimes there is a chapter added on histology, or embryology, or on landmarks. In general the great bulk of the book remained unaltered until the 13th American edition appeared. However, this revision was not fortunate, and in the 15th edition we find the radical changes in it replaced in large part by the text from a previous English edition.

It is evident that the gradual and minor changes which we witness from edition to edition of Gray indicate that the science of anatomy is still developing, and any one familiar with its great literature would not hesitate to state that its development during the past 50 years has been very great. Anatomy can be viewed to advantage from other standpoints than the surgical, and its progress during the past century is due largely to those who have studied the subject from general, physiological, comparative, developmental, anthropological, and artistic standpoints. Furthermore, it is now questionable whether it is best for the student of medicine to study anatomy from the surgical standpoint alone, for it is probable that the greatest use to be derived from its study, outside of the discipline of a good laboratory course, is its value to the student in his subsequent study of physiology, pathology, and internal medicine, not to speak of the numerous specialties.

So if it is a fact that anatomy is growing and is of use to other branches of medicine than surgery, it follows that its scope should be morphological and general as well as descriptive. We should, therefore, not like to see Gray condensed and compact like Gerrish, but rather rewritten to include all of the modern work as has been done in an admirable way by Cunningham. Cunningham's anatomy is a clear-cut descriptive picture of the science of anatomy in 1902, as is Gray's of the science in 1850. The question now is whether the last revision, which is the only extensive one which has ever been undertaken, is thorough and complete and brings the subject fully up to date. Furthermore, the substance should be selected carefully, fundamental things should be emphasized, the growth of the science should be indicated, and enough references to the literature should be given to enable the student to find some of the important articles of the three or four thousand on anatomy which appear in some six hundred journals each year. This last point is extremely important, for if the work of the student of anatomy is to be of lasting value in later years he must come back to the subject from time to time and extend his knowledge in definite directions, and he naturally uses his old text-book which aids him if it has in it references to the literature which have been carefully and properly selected, as is the case in the anatomies of Quain, Henle, Gegenbaur, Testut, and Poirier and Charpy. Then it is also to be remembered that the structures of the body are variable, some very much so, and an erroneous impression is left upon the student's mind if the book studied does not give the variations as far as they are known. In this respect Quain's and Henle's anatomies are satisfactory, for the variations are given in a very few words.

We read in the preface of the new Gray that in order to represent the world's best knowledge, American, English, French, and German text-books, monographs, and journal articles have been freely consulted, and that in every instance the aim has been to give proper credit to the author. It is further stated that the work is descriptive and surgical, histology and embryology having been omitted. From this standpoint then its work must be judged. We note especially in glancing through the pages that Gerrish, Cunningham, Toldt, Spalteholz, Poirier and Charpy, and Testut have been consulted freely, and to the extent in which this material has been blended with the original Gray the work has been markedly improved.

Numerous illustrations have been borrowed from the above-named sources and they have been carefully and beautifully re-engraved on wood in imitation of the illustrations retained throughout all of the former editions. However, the original pictures have a peculiar character which cannot be imitated easily by engravers unless they also have drawings made by Dr. Carter. In fact, these original illustrations are the best feature of the book, for the anatomy shown in them is simple, complete, and satisfactory, and their execution is concise and artistic (see, for instance, Figs. 648, 649, 650, 656, and 657 to illustrate the nerves of the lower extremity). The names of the parts are engraved in a delicate way on the original figures, a method used in Berenger's anatomy (1521), and from time to time since then. On the borrowed pictures in Gray the lettering is harsher and mars very much their beauty.

The original figures in Gray were pirated by Heitzmann, of Vienna, to form the major portion of his Atlas, which for many years was the favorite dissecting-room book in German laboratories. One of the inducements to produce the Atlas of Spalteholz was this pirated book, which was not adequate for the needs of German teachers, and it is a happy sequence that the book which indirectly stimulated the production of Spalteholz's Atlas should in turn be benefited by it. The great value of an atlas is that it enables the student to look ahead while making a dissection and to identify the parts as they are unraveled. Pictures of dissections true to nature aid the imagination of the student enormously and thus guide his work from the known to the unknown. It follows that the illustrations of an anatomical atlas must be typical, giving all the stages of a dissection from its beginning to its completion. The Atlas of Spalteholz meets this requirement, as does that of Toldt, and in a measure this may be said of the illustrations of Gray. In general older students and physicians leave the text and study the figures of Gray, and this fact speaks immensely in their favor. If a student's mental

picture of the structure of the body is good, in later years good illustrations will enable him to recall his anatomy better than the text alone. I am sure that to look up a question of topographical anatomy Toldt's plates will prove to be of far greater value than Hyrtl's fascinating work, which contains no illustrations at all. A blending of the two makes a good combination, the method usually employed in Austria.

The only marked improvement which could be suggested regarding the illustrations in the new Gray would be to include more of Toldt's and of Spalteholz's pictures, but, of course, this is out of the question. A number of illustrations to represent the early growth of bone, as in the 2d edition of Cunningham, would improve the section on osteology. The wrist and ankle bones are not as well illustrated as in a number of other works. The muscles of the back need an additional illustration or two. A number of figures are not especially good, *e. g.*, Figs. 396, 408, 426, 432, 433, 536, 602, 633, 670, 677, 684, 688, 693, 899, 978, and could be omitted to advantage. Also the following corrections may be made: Fig. 496 is after Poirier and Charpy; on Fig. 315 pectoralis major is called pectinius major, an error which appeared in the 13th edition; Fig. 503 is not properly copied; on Fig. 578 we read *knie* and *bein;* the legends of Figs. 112, 113, and 114, 115 are reversed; Fig. 842 is after Hertwig; Fig. 908 is after Ramon y Cajal; and Fig. 955 is not after Poirier and Charpy but after the late Dr. Hendrickson, of Philadelphia. Furthermore, the lack of uniform labeling of the figures is rather confusing to the beginner. An example is seen in Fig. 753, anterior auricular muscle, which in Fig. 755 is called attrahens aurem. In general the excellent progressive illustrations, with uniform lettering, in Cunningham makes these pictures more intelligible to the beginner, for the pictures fit into one another and the language is not confusing. In this book the old edition has passed into the new without a break in the illustrations, as is also the case with the new edition of Spalteholz; in both cases the character of the illustrations has been retained and improved.

The text of the new edition of Gray has been changed to a great extent, several chapters having been entirely rewritten. The task in blending the old Gray with a number of recent text-books is not an easy one and it is questionable whether a composite of this sort can ever bring a first-class result. As it is the editor has done remarkably well in dealing with the thousands of facts in anatomy, but we fear that this happy mean will be difficult for beginners to follow, and of little value to advanced students, for the literature of anatomy is not dealt with first-hand, but has only filtered in, mainly through Cunningham and Poirier and Charpy. Furthermore, no references are given to the many anatomical journals, with the one exception of the Journal of Anatomy and Physiology. At present there is an immense activity in anatomical research, even in this country, and we are rather inclined towards text-books which deal with the literature first-hand, for those who do this are most likely to give a clear, compact, and well-proportioned description of the subject. This is the case with Cunningham, and to a more marked degree with Quain. In the latter book, for instance, osteology is treated in a most satisfactory way in half the space that is devoted to it in Gray, and we have here a well-written text which on account of its compactness and accuracy is to be recommended to beginners, and on account of its scientific attitude and its numerous references to the literature is the best book for the advanced student who wishes to extend his reading to monographs and journal articles. In general the text in Gray is involved and diffuse, and although it is built up from crystals it needs re-crystallization. We mean that it should be briefer, things scattered should be brought together, and irrelevant matter should be removed. It should be a well-proportioned, readable work like the second edition of Cunningham. Were we dealing with the first edition of Gray we would be more lenient, but a great work, which is in its 16th edition, must be criticized from a high standpoint.

Considering the number of pages in Gray, it is remarkable that there are so few references to the literature of anatomy. The anatomical journals are almost entirely ignored, but monographs are referred to occasionally. However, the article by Delamere, Poirier, and Cuneo is referred to 21 times (three times on one page) in the chapter on the lymphatics; once would suffice. When we consider that in Quain's Anatomy the same ground is covered in fewer pages than in Gray, that the descriptions are clear-cut, accurate, and complete, and that the references are sufficiently numerous to lead the student into the whole history of anatomy, we feel disappointed over this omission.—Every part of the body varies, some parts so much that it is difficult to determine the normal, and the literature upon variation is so great that no book is complete unless it leads the student, who is so inclined, to the limits of our knowledge. That this may be done in a book smaller than Gray is shown in an admirable way in Quain. This work being an American edition, we naturally expect to see more of our own literature referred to. However, it is gratifying to see Miller's work upon the lung and Hendrickson's on the bile-duct creeping in through foreign books, probably Poirier and Charpy.

One of the greatest stumbling blocks in the study of anatomy is the nomenclature, and it has always been so. During the past century a number of attempts have been made to introduce a uniform terminology, however with little success until the work was undertaken by an international commission composed of many leading anatomists—Turner, Cunningham, and Thane representing England. After working six years a satisfactory report was rendered which is now generally accepted. That these terms are adopted as synonyms in Gray is to be commended, and adds immensely to the value of the book. However, the main point is missed by using the terms indiscriminately, for it is not *Latin terms* but *uniform terms* that the commission strove to introduce. In casting the new nomenclature 30,000 terms were reduced to 5000, and of these not over 250 differ from those used in older editions of Gray. For instance, in the new terminology (B. N. A.) in English

a certain muscle of the ear is called the superior auricular, and to use in different parts of Gray the synonyms atollens auriculam, atollens aurem, auricularis superior only tends to confuse the student. Many more examples could be given; the worst we have noticed are the various synonyms (six) for colliculus superior. One name, best the new one, should be used consistently throughout the book, as is the case in Cunningham, with the synonyms in foot-notes, and if the anatomy is to be a book of synonyms, many more could be found than are given in this edition of Gray. Possibly, in its transition stage, it is well to treat this subject as it has been treated in Gray, but it seems to us a pity that the beginner should be tormented so much for a paltry 250 words when the many thousand synonyms could be pushed out of the main text into foot-notes, as in Henle, for those who wish to use them. They could then be brought together in an index, or in parallel columns, as in the "day-book" of the international commission, to form a second royal octave volume of a thousand pages and be of great service to advanced students.

What is said about nomenclature applies equaly well to measure. Most of the measures are given in feet and inches, but we often notice centimeters, millimeters, and microns. The metric system should be used throughout the work.

The section on osteology is one of the easiest to deal with in descriptive anatomy, and we find this subject treated in a satisfactory manner in the new Gray. The first fifteen pages are devoted to an excellent introduction to osteology and the rest of the chapter (over 200 pages) to a good description of the bones. We are of the opinion, however, that a large portion of the text might be omitted, for the description is already given in the many excellent illustrations. The question of ossification, which has always been well illustrated in Gray, is not quite up to date, as may be noticed by comparing it with the second edition of Cunningham and with the new Hertwig. X-ray pictures and Schultze preparations have given better data regarding the early ossification of bones, and we see other recent books taking advantage of these methods. We notice, for instance, that Gray states that the body of the vertebra has two centers of ossification, an error that is not to be found in the earlier editions. Why this mistake ever crept into the book is hard to explain for the double centers were exploded by Meckel in 1815 and have not been seen by any competent investigator since that time. The foot-note on this point shows that the English editor knows that the statement is out of harmony with the literature, and we may add with the facts which are correctly stated in the first edition of Gray.

Physical anthropology should also be considered more than it is, for there is no telling when a doctor is to be called upon to give an opinion regarding the age, sex, and race of a skull, and before he does it he naturally falls back upon his text-book. In this respect he will find Quain, Gerrish, and Cunningham adequate. We do notice that there is a brief account of the size and form of the cranium, copied from Cunningham, on page 146 in Gray. Unfortunately, the formula to determine the cephalic index was not given correctly in the first edition of Cunningham, and it is taken over blindly with its blunder.

The chapter on the ligaments is greatly improved by the introduction of new figures and the revision of the text. However, it lacks the well-proportioned text found in Cunningham, and for this reason will not be as useful to students as that in some other books. The paragraph on the motions of the elbow joint, for instance, is diffuse, while that in Gerrish is shorter and gives more information. In Quain we also find a satisfactory description of the elbow joint and in addition a reference to the article from which the information was obtained.

The chapter upon muscles in Gray is considerably longer than that in Quain and twice as long as that in Cunningham, and does not contain any more information if we overlook the notes on surgery. Our experience is that the description in Quain is the most satisfactory and gives in addition numerous satisfactory notes on variations. Much space in Gray is devoted to the discussion of the relation of the muscles to one another, as well as to the surrounding parts, which might be greatly abridged, as well as aided by a number of transverse sections. The value of this method to illustrate relations and attachments is well shown in Fig. 295, giving a transverse section of the abdomen in the lumbar region. The descriptions of the individual muscles, while not especially full, are fairly good. In the introduction (p. 361) the descriptions of the muscle cells are far from lucid and accurate. In the next paragraph it is stated that the muscle fibers may be 10 cm. long, while on page 363 we read that those of the sartorius are nearly two feet in length. Several other minor errors are to be seen scattered through the chapter (pp. 368, 376, 394, and 181); however, such errors are not peculiar to Gray, for they exist in all books.

The sections on the vascular system are much in need of recasting, for the variations of the vessels are numerous and their position is of great interest to the surgeon. The general anatomy of the heart, arteries, and veins is meager and flavored somewhat with teleology.

In view of the recent important work upon the heart, this subject should be introduced with embryology, which gives a rational explanation of variations, and the heart musculature should be described according to MacCallum, who was the first to unravel this complicated structure successfully. The little bundle of His, Jr., which is of the greatest physiological and clinical importance, is also ignored. For the present the chapter on the musculature of the heart is better in Quain than in any other text-book, and it is not rash to predict that the newer work upon this subject will find a place in the next edition.

Within the last half century many studies have been made upon arterial variations, as may be witnessed by consulting the numerous articles in the anatomical journals, and some forthcoming book must incorporate this work. Not only must the extreme variations be recorded, but the types of distribution must be given also. For instance, Hitzrot has shown that

the usual description of the axillary artery occurs in but 20 per cent of the cases. And very recently Bean has demonstrated that the branching of the subclavian artery, according to the description in Gray and Quain, is much more common on the left side than on the right, while according to the B. N. A. (Spalteholz and Toldt) the opposite is the case. Gray's description is found present in 27 per cent of all the cases studied, and the B. N. A. description in 30 per cent, leaving other types to account for the remaining 43 per cent. From these and other studies it is clear that the iron-bound description as followed by most anatomists is misleading to the student and injurious to the surgeon.

There is one other general item which requires reform; it is the description of the relation of the arteries to the surrounding structures. A round ring with names printed on four sides, as given in Gray, may possibly be of value, but when we see such excellent figures of sections as are given in Merkel's great topographical anatomy, or in Oskar Schultze's topographical atlas, we question very much their use. Furthermore, these latter figures are much better and are not misleading, for a circle has more than four sides to it and the surrounding structures are not of equal size. Gerrish, Merkel, and Schultze take advantage of the section to a certain extent, and the recent works of Jackson and Potter show what may be done with it with medical students in Missouri. Now that cross-section work has been well established in most of our leading medical schools, it is to be hoped that books may be revised to meet our needs more than the ones that are at present at our disposal.

The chapter on lymphatics is very satisfactory, being based largely upon the excellent article by Poirier and Cuneo. The introduction, which should have more of Delemare in it, is unsatisfactory, for it has in it a vague notion regarding the extent of the lymphatic system. The description of the lymph-node is much too brief and inadequate. It is stated that the pleural, pericardial, peritoneal, and synovial cavities belong to the lymphatic system. Also that the valves are absent in lymphatic capillaries and seldom found in visceral lymphatics. These two statements show that the literature has not been consulted freely. However, it is a pleasure for us to note that the greatest progress in the study of the lymphatics in recent years has been made in America by Sabin and MacCallum, of Baltimore; by Lewis, of Boston and by Warthin, of Ann Arbor. The work of the first three investigators defines the extent of the lymphatic system morphologically and the last named author gives us the best description of the hemolymph-nodes in man. This work has received due recognition abroad, some of it is incorporated in the second edition of Cunningham, but none of it is mentioned in Gray.

One of the most difficult chapters to write is that on the nervous system, although we have a large number of excellent monographs to draw upon. Our standard is a book like Van Gehuchten or the recent excellent and "life-like" account given in the last edition of Edinger. A most satisfactory, complete, and modern account of the brain is given in the second edition of Cunningham. The facts in general appear to be correctly stated in the new Gray; some errors, however, have crept in.

The absence of a clear and systematic method in the presentation of the central nervous system renders the description of this complicated structure more confusing than is necessary. Isolated facts are given without sufficient correlation and without consistent sequence. One finds, for instance, the structure of the cerebrum, its commissural and association fibers described under the heading mid-brain (p. 913 ff.), together with those structures in the region of the aqueduct of Sylvius. Another striking feature is the absence of uniformity in the treatment of different regions. More than 16 pages are devoted to the surface markings of the cerebrum, which could have been largely shown with illustrations without any text; while the internal structure of the medulla receives but 6 pages. The pons, medulla, and cord all suffer for want of good illustrations showing cross-sections. There are but two of the cord, which, by the way, are wrong side up (pp. 838 and 844). No attempt is made to show the appearance of the various levels.

So many nerve-paths come together in the medulla and there is gradual transition of the medulla into the cord that for purposes of description and teaching it is much easier to pass from the cord to the brain than in the opposite direction. It follows also that the description of the medulla should be accompanied with numerous accurate pictures of sections at regular intervals, a method introduced by Stilling and followed in all of the great books on the brain. Such pictures are wanting in Gray. The gross illustrations (Figs. 604 and 606) of the floor of the fourth ventricle are crude and should be replaced by a new illustration from Retzius or by the excellent one from Streeter's article, which may be found in Edinger's Neurology. Furthermore, the description of this difficult region could be made clearer by Miss Sabin's reconstruction of the medulla, which shows the nerve paths in three dimensions.

It is stated on page 818 that neuroglia fibrils develop from the prolongations of neuroglia cells; the work of Weigert and of Hardesty is not considered. There is also a paragraph on complete fissures (865) which is based upon Cunningham's original article upon this subject. Later, in the first edition of Cunningham's Anatomy, less stress is placed upon the significance of these fissures, and since we have the results of Hochstetter and of Retzius it would be better to omit them altogether. On page 903 the posterior commissure is described as belonging wholly or principally to the inter-brain, and on page 905 the anterior pillar of the fornix is described as going through the optic thalamus. It would also be well, we think, to add the pulvinar to the diagram on page 1023.

The organs of special sense are treated in a satisfactory manner in Gray, taking up more space, however, than in Cunningham and in Quain. A brief description of the development of the eye and ear and of the gustatory organs would add to the clearness of this section. We make the same criticism

of the section on the genito-urinary organs; they should be treated somewhat as is the alimentary canal on pages 1236-1245.

It would be well in describing the regions of the abdomen to give as well those recommended by Toldt and adopted by the international commission (B. N. A.), for they seem to be less variable and therefore of more value to the clinician. A more detailed description of the blood-vessels of the walls of the small intestine as well as the position of this organ is pertinent on account of frequent operations upon these structures. For this change space might be gained by omitting the paragraphs on the movements of the stomach and the intestines, which really belong to physiology. Five references to an article on the movements of the intestine are given on page 1323; one would suffice. The description of the structures of the liver and spleen have been excellent in all editions of Gray, one based upon the work of Kiernan and the other upon Gray's monograph. They illustrate well the advantage in compiling text-books from first-class studies, a method employed to great advantage in the various editions of Quain. At this point we go out of our way to mention Miller's work on the structure of the lung. He finally cleared up the relation of the air-cells to the terminal bronchus and to the blood-vessels, and his work has been incorporated in nearly all of the great European anatomies. It was he who introduced the term atrium, which we see mentioned on page 1378 of Gray. According to the index atria appear to be peculiar to the left bronchus.

We do not believe that a descriptive and surgical anatomy is complete without a chapter on superficial and relational anatomy. One may be found in Quain, in Cunningham, and in Gerrish, and for a number of editions Holden's Landmarks were published as an appendix to Gray. In recent years nearly three volumes of Merkel's great work have appeared, not to speak of the excellent atlas and text-book of Schultze and Stewart. Possibly the excuse for the omission of this important chapter from Gray is to be found in its large number of excellent new figures, as well as the wide distribution of Spaltholz, Toldt, and other atlases.

The above remarks, a little more numerous than are usual in an article of this kind, are made in the interest of anatomy. That a book like Gray, which has become so firmly established with us, is extensively revised and in part rewritten indicates that anatomy is developing in America. At present we are drawing heavily upon Germany, England, and France for light, and the new Gray comes forward to meet the demand.

We congratulate the editor and the publisher upon the many improvements of Gray in this edition, and hope that it will soon be given a new revision in which a uniform nomenclature is used, irrelevant matter cut out, the text made clear-cut and compact, and much of the new literature added, as is the case with each new edition of Quain. Possibly in a few years we may rise to the point of having real American anatomies, books good enough to export, like Minot's Embryology, and we should not be contented until this is the case.

A VARIATION IN THE SOLEUS AND PLANTARIS MUSCLES.

By D. H. DuPree.

(From the Anatomical Laboratory of the Johns Hopkins University.)

While dissecting in Dr. Mall's laboratory last winter I found the following variations, which he has given me permission to describe. The body in which they occurred was that of a negro male, No. 1217 in the collection. The variations consist in the absence of the plantaris in the right leg, and its peculiar insertion and size in the left leg, and of an extra slip in the soleus in the left leg.

The Soleus.—In the left leg of this cadaver the soleus consists of (a) a lateral head and (b) a median head, a deep groove running between them on the posterior aspect; and (c) of an *extra slip* anterior to the median head, which is inserted into the calcanean bone by a tendon of its own. The lateral head rises from the posterior surface of the head and upper third of the shaft of the fibula. Its origin is fleshy and tendinous, the tendon of origin running in the substance of the muscle and appearing on the anterior surface by its edge. The fibers are inserted into a broad aponeurosis on its posterior surface and thereby into the tendo Achillis, except some of its anterior fibers, which blend with the middle head in the upper third of the leg. The median head arises from the inner border of the tibia in its upper third, and the oblique line of the same bone, and from the tendinous arch covering the posterior tibial vessels and nerves. Its fibers are inserted into an aponeurosis on its posterior surface and thence into the tendo Achillis. However, some of its fibers blend with those of the lateral head, as is seen on looking into the depth of the groove separating the two heads on the posterior surface. Moreover, in the upper third of the leg this part of the muscle is inseparable from the extra slip.

The extra slip rises in common with the median head. It lies on the anterior surface of the soleus and is blended with the median head in the upper part of the leg, as mentioned above, except for a shallow groove running between them along its lateral margin. In the lower two-thirds of the leg it is independent of the rest of the soleus. On its free posterior surface, *i. e.*, below its separation from the median head, there is an aponeurosis from which fibers arise to be inserted into a tendon on its anterior surface. The tendon of inser-

tion is broad above, but narrows as it approaches the ankle, and comes to lie on the mesial border of the muscle. It is inserted into the mesial surface of the os calcis near its posterior margin. This extra part of the soleus covers the posterior tibial artery and nerve throughout its extent. It is about the size of the middle head.

The blood supply of the median head comes from the posterior tibial artery. The extra slip receives four branches from the posterior tibial artery during its course under the muscle, and it also gets a branch from the peroneal just before this artery disappears under the flexors. The lateral head gets its blood from the peroneal artery.

The extra slip gets its nerve supply from a branch of the posterior tibial nerve in the upper third of the leg and it also receives a twig from a branch of the same nerve going to supply the median head. The lateral and median heads get their nerve supply from branches of this nerve.

The soleus is normal in the right leg of the cadaver.

In the embryo the mesenchyme of the hind limb differentiates into a central bony mass and a ventral and dorsal muscle mass, this differentiation progressing from the body distalward. The muscles become attached above first and later get their distal attachments to the bone. Hence it is easy to conceive that this extra slip of the soleus for some reason got separated from the rest of the muscle and extended on down the leg until it finally got attached to the os calcis by a tendon of its own.

Le Double says that in comparative anatomy this muscle is very variable in its development, and is absent in many species, among which are the kangaroo, the dog, etc. According to Quain, "the tibial head of the soleus is almost peculiar to man; among the lower animals it occurs, of small size, only in the gorilla and sometimes in the chimpanzee."

A number of anatomists have reported similar variations of the soleus. Henle mentions a "broad bundle going from the mesial surface of this muscle (soleus) to the mesial surface of the heel-bone."

Quain says that, "to the soleus an accessory portion is occasionally added at its lower and inner part; this usually ends on the inner side of the tendo Achillis, but it is sometimes attached separately to the os calcis, or to the internal annular ligament."

Turner, in writing on the frequency of the occurrence of accessories to the flexors in the region of the inner ankle, mentions "A long slip springing from the inner side of the soleus, and passing quite distinct from the tendo Achillis to be inserted into the inner concave surface of the os calcis."

L. Testut mentions the fact that the tibial head of the soleus is wanting in nearly all monkeys. He says that "one encounters sometimes, besides the normal soleus, a supernumerary soleus, which generally ends on the os calcis on its mesial surface," and arising from "the oblique line of the tibia, the soleus surface of the same, and the deep fascia of the leg, etc." He mentions a case in which he found "in the right leg a supernumerary soleus and a long accessory to the flexors, both well developed and fused into a single muscle. This muscle covers entirely the peroneal and tibial arteries."

Le Double says, "one sometimes finds a supernumerary soleus muscle, small or large, situated in front of the soleus, having the same origin with it and inserted into the os calcis by a separate tendon." He quotes the references above to Quain and Testut. He says that Testut regards this accessory soleus attached separately into the os calcis as a variety

Fig. 1.

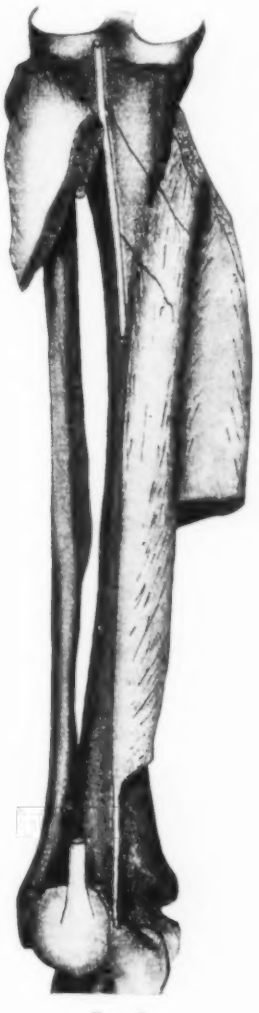

Fig. 2.

Fig. 1.—Dissection of left leg of No. 1217, showing attachment of extra slip of soleus to inner surface of os calcis, and the insertion of the tendon of the plantaris into the tendo Achillis at lower end of the middle head of soleus. The gastrocnemius has been cut away.

Fig. 2.—The soleus has been divided in upper third of leg and middle head and extra slip turned inward to show origin of extra slip and its relations to the rest of the muscle. The nerve exposed is the posterior tibial.

of plantaris, and disputes this view on the ground that it comes from the deep surface of the soleus and that it often co-exists with a well-formed plantaris.

The Plantaris.—In this subject the plantaris was entirely absent in the right leg. In the left leg it was very much reduced in size. Its origin was normal, but its slender tendon was inserted into the inner border of the tendo Achillis about half way between the knee and the ankle.

According to Quain, Gruber, and Le Double, this muscle is absent in man in about 7 per cent of subjects dissected. Le Double says that it is rarely absent in races of color. In anthropoids it is often absent also (Quain, Le Double).

The insertion of the plantaris is very variable and cases are mentioned in which it was found to end in the tissue separating the superficial from the deep muscles, the internal portion of the annular ligaments, the bursa or the os calcis under the tendo Achillis, or the plantar fascia (Le Double). Quain says that its tendon may be "sometimes enclosed in the lower part of the tendo Achillis."

In many of the lower animals the plantaris continued into the plantar fascia is a superficial flexor of the toes—the homologue of the palmaris longus. In man, using his feet only as a support to the body, the plantar fascia became attached to the os calcis and the plantaris is left only as a vestige (Le Double).

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THE PANCREATIC DUCTS IN THE CAT.

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The pancreas was known to the earliest investigators, and has been the subject of frequent study, especially with regard to its physiological and pathological significance. Whether it was known to Hippocrates is doubtful. Galen recognized the presence of the pancreas but was uncertain as to its significance. He thought that it served as a protection for the arteries, veins, and nerves which divided near it. As Galen was considered the authority by all following physicians and anatomists, his view was not questioned and it was not until the time of Vesalius, the founder of modern anatomy, that the authority of Galen was overthrown. Vesalius, although he overlooked the significance of the pancreas, made some important observations as to its attachment to the duodenum and its position in the omentum. After the time of Vesalius nothing of real importance was done on the pancreas until toward the middle of the seventeenth century, when Wirsung discovered a pancreatic duct in man, opening into the intestine in connection with the ductus choledochus. Other investigators, as Vesling, in 1664, and De Graaf, in 1671, showed that in man there were sometimes two ducts, the larger opening into the duodenum with the ductus choledochus, the smaller independently. These investigators, however, thought that the presence of two ducts was anomalous.

In 1775, Santorini established the presence of two ducts as the normal condition. He described the ducts in man and gave figures showing their relation. His work, however, seems to have been forgotten or ignored until the time of Bernard in 1846. Bernard called attention to the constant presence of two ducts in the adult and his observations, together with those of other prominent anatomists, established the presence of two ducts as the normal condition. Even after the time of Bernard, the presence of two pancreatic ducts in many mammals was overlooked. Chauveau states that in the ox, sheep, goat, pig, dog, and cat, the excretory duct of the pancreas is single and opens into the intestine at varying distances from the pylorus. Since the publication of this work, it has been found that instead of one duct there are normally two ducts in the ox, horse, dog, and cat, and it is probable that further investigation will lead to the same conclusion in many other mammals. Of the more recent papers on the ducts of the pancreas, Gage has described the ampulla of Vater and the pancreatic ducts in the cat, and Revell has described the pancreatic ducts in the dog.

The pancreas of the cat has been studied to a slight extent both from the embryological and anatomical standpoint. The fullest account of the development of the pancreatic ducts of the cat is that of Felix. He states that in embryos 9 mm. long there are two pancreatic anlages, one dorsal and one ventral. Later, in an embryo 11 mm. long, the dorsal bud is only slightly developed and thus it comes about that in the adult only one pancreatic duct is present.

Schirmer studied the ducts in the pancreas of the cat in 17 animals. He found that the form and size of the pancreas varied greatly. He described two ducts, a larger which

opened into the duodenum with the ductus choledochus and a smaller which opened independently 3-7 cm. caudad to the first.

Gage, as already stated, worked on the ampulla of Vater and pancreatic ducts in the cat. He found two ducts, the larger opening into the duodenum with the ductus choledochus, the smaller independently.

From the study of the development of the pancreas in many mammals and vertebrates, the fact is well established at the present time that the pancreas arises from at least two anlages, one arising from the dorsal, the other from the ventral wall of the duodenum. More recently the presence of three pancreatic anlages has been found in man and in the chick, of which one is dorsal, the other two ventral. The two ventral anlages later fuse to form a single bud. The two anlages, the dorsal and ventral (whether single or formed by the fusion of two ventral buds) grow away from the duodenum and cross each other, fusing at the place where they cross. Correspondingly there are two ducts present which almost always anastomose with each other within that part of the gland which is formed by the fusion of the two anlages. The relation of these two ducts is subject to variation, but there is one type which occurs most frequently in each species and this type is called the normal. It was to find, if possible, this "normal" in the cat as well as to work out the distribution of the pancreatic ducts that the following work was undertaken.

The material used included, (1) 35 animals, of which 3 were fixed with formalin for the study of the topography. The pancreas of each of the 35 animals was examined with regard to its shape, the presence of an arm or bridge of pancreatic tissue (to be described later), the position of the opening of the ducts into the duodenum, and, with the exception of the 3 cases fixed with formalin, to the distribution of the pancreatic ducts as determined by the injection of a starch mass or by celloidin corrosions. (2) 3 animals were used for sections of the intestine through the ampulla of Vater; one for cross-sections of the duodenum and two for longitudinal sections, the two latter being at right angles to each other. (3) 2 animals were used for cross and longitudinal sections of the duodenum through the opening of the ductus accessorius.

Topography.—For the study of the topography of the pancreas, the animals were killed with chloroform, supported in their natural position and fixed by injecting a 10 per cent formalin solution into the carotid artery. After allowing the animal to remain for several hours or over night, the viscera were firmly fixed and hardened, and the position of the pancreas and its relation to the surrounding parts could be accurately determined (Figs. 1 and 2).

The pancreas in the cat is almost without exception cream-colored, of an elongated flattened form, being from 8-12 cm. long, 1-3 cm. wide, and .2-1 cm. thick. The size varies considerably even in animals of the same weight. It is made up of various sized lobes and lobules bound together by connective tissue. The free margins of the gland are irregular in outline.

At about its middle, the pancreas is bent acutely on itself, the straight lines including most of each half making an angle of about 45 degrees with each other. The apex of the angle lies dorsal to the pylorus. The right and left legs of the triangle were, in the 3 cases fixed with formalin, about equal in length. In examining other cases of fresh material, the left limb or cauda pancreatis sometimes appeared to be the longer.

The right limb or caput pancreatis (termed also the duodorsal portion) lies on the right side of the abdominal cavity. It follows the course of the duodenum, being attached to its median wall. In some cases it extends caudad as far as the U-shaped bend (pars horizontalis) of the duodenum; in other cases to within 1-2 cm. of the bend. The general direction of this limb is parallel to the antero-posterior axis of the animal.

The caput pancreatis is much flattened and has a dorsal and ventral surface. The dorsal surface lies ventral to the caudate lobe of the liver and the right kidney. The ventral surface is slightly hollowed. Into the hollow fits the dorsal wall of the ascending colon.

The left limb or cauda pancreatis (termed also the splenic portion) runs in the dorsal wall of the great omentum across the abdominal cavity, its long axis making an angle of about 45 degrees with the antero-posterior axis of the animal. It is narrower and thicker than the caput. The cephalic half of the cauda lies anterior to the transverse limb of the large intestine. Its anterior border lies dorsal to the greater curvature of the stomach. Its posterior surface is hollowed to receive the transverse colon. The posterior half of the cauda is flattened laterally and has a right and left surface. The left surface lies adjacent to the posterior portion of the spleen; the right surface is much hollowed to receive the descending colon. The cauda pancreatis as a whole lies ventral to the left kidney and adrenal body and dorsal to the stomach and coils of the intestine.

Lying in the plica duodeno-jejunalis between the caput and cauda is a narrow strip of glandular tissue, the shape of which varies considerably (Fig. 2, *C*). It is characteristic in the cat, having been found in every adult animal examined. It occurs in two forms, either as a bridge connecting the caput and cauda, or as an arm or spur, that is, an outgrowth from the caput or cauda but not joining the two limbs. The former type is by far the more frequent. Of 35 cases examined, the bridge type was present in 25, the arm or spur type in 4, an incomplete formation in 5, while in 1 case, a young animal, the structure was absent altogether. When present as an arm, this strip of glandular tissue is clearly an outgrowth from either caput or cauda as the case might be. When present as a bridge it is apparently formed by an outgrowth from both caput and cauda, the two arms meeting and fusing to form the bridge. This is indicated in the 5 cases of incomplete formation of the bridge. In 2 of these there was an outgrowth into the plica duodeno-jejunalis from both caput and cauda, the two spurs approaching each other but still remaining widely separated (Fig. 3, I). In one case the two

arms had approached to within a millimeter of each other but were still distinctly separate (II). In 2 cases the two arms had slightly overlapped and between the two there had formed an extremely narrow strip of glandular tissue (III). This stage closely approximates the normal condition in which the fusion between the two arms is complete (IV). In all cases which were observed, the fusion of the two arms took place immediately dorsal to the arteria mesenterica superior and vena mesenterica superior which pass between the two limbs of the pancreas.

Pancreatic Ducts.—The pancreatic ducts in the cat were studied by dissections of hardened injected material and by celloidin corrosion preparations. The latter method was used in the majority of cases. The preparations were made by injecting celloidin into the ductus pancreaticus (Wirsungiania) with a hand syringe and then digesting the pancreas in pepsin (Fig. 4).

In describing the ducts the same general plan will be followed as was adopted by Revell in his description of the pancreatic ducts in the dog. The ducts then will be described in three parts:

(1) Intraglandular—lying within the gland.

(2) Free—between the gland and the wall of the duodenum.

(3) Duodenal—within the wall of the duodenum.

Ductus Pancreaticus (*Wirsungiania*).

(1) Intraglandular Part.—The ducts arise in the lobules as the intermediate ducts (called also intercalated ducts) formed by the union of the secretory capillaries of the end pieces of the gland. The intercalated ducts unite to form the interlobular ducts. The interlobular ducts unite usually like a letter Y. The stems of these Y's form the arms of larger similar Y's. The planes of successive Y's are at various angles to one another, being sometimes at right angles but oftener at angles less than 90 degrees. Very often instead of the Y form of union the ducts unite T-like. The union of the ducts is not confined to this Y-like or dichotomous form. It frequently happens that three branches unite at one point, all of which lie in different planes (Fig. 5, I).

The interlobular ducts unite to form the lobar ducts. Each lobar duct runs near the axis of the lobe toward the axis of the gland, being joined by lobular branches by which its diameter is constantly increased. The union of the interlobular ducts to form the lobar ducts continues to be dichotomous, especially in the case of the shorter ducts, and often is so up to the point of entrance of the lobar duct into the axial or main duct (Fig. 5, II).

In or near the axis of each limb of the pancreas runs the main or axial duct. It arises from the extremity of each limb by the union of the lobar ducts. Each axial duct runs toward the duodenum and in its course receives the lobar ducts from all sides and at varying angles of junction. The axial ducts receive also the branches from the bridge or arm of the pancreas. In the bridge type these branches are two in number. They arise together near the middle of the bridge by the union of small branches and pass in opposite directions, the one joining the axial branch of the cauda, the other entering into the formation of the axial branch of the caput (Fig. 4, *A* and *B*). In most cases the two branches were distinctly separate at their point of origin. In three cases an anastomosis took place between the two branches, the union occurring in the portion of the bridge which lies dorsal to the blood vessels previously spoken of. This distribution of the ducts indicates also the way in which the bridge is formed. In the arm type there is a single branch which joins the axial duct of the caput or cauda as the case might be.

The axial branch from the caput meets that of the cauda adjacent, that is, to the left of the opening of the ductus choledochus, the union taking place toward the dorsal surface of the gland. From this point of union the duct continues toward the duodenum as a thick trunk from 4.5 to 9 mm. long which frequently receives a few short branches in its course. It emerges from the pancreas near its dorsal surface and continues toward the intestine as the free part of the ductus pancreaticus.

(2) Free Part of the Ductus Pancreaticus.—This is to be sought for on the dorsal side of the duodenum. It is near the anterior end of that part of the pancreas which is directly applied to the duodenum. The dorsal edge of the pancreas overlaps it and conceals its passage to the duodenum. The best guide to it is the ductus choledochus. This can easily be distinguished by its brownish or greenish color due to the bile within it and can readily be traced to its point of entrance into the wall of the duodenum. At this point the wall of the duodenum is slightly bulged out due to the ampulla of Vater. By lifting up the dorsal edge of the pancreas, the ductus pancreaticus will be seen as a whitish band (or other color if injected) passing from the pancreas to the wall of the duodenum and entering it immediately caudad to, and almost in contact with, the ductus choledochus. It is from 1 to 3 mm. long and 1.5 to 2.5 mm. in diameter. Its course toward the intestine is usually slightly caudad.

(3) Duodenal Part of the Ductus Pancreaticus.—This is from 2 to 3 mm. long and 1.5 to 2.5 mm. in diameter when distended. The duct enters the wall of the duodenum on its left dorsal side and curves around it toward its median dorsal side. Its course through the wall of the duodenum is oblique, the duct being directed caudad and making an angle with the longitudinal muscle coat of the duodenum which varies from 20 to 70 degrees. The duct opens together with the ductus choledochus into the ampulla of Vater, an enlarged space in the dorsal wall of the duodenum. The ampulla communicates with the lumen of the duodenum by a single opening which forms thus a common opening for both the bile and pancreatic ducts. This opening is situated at or a little caudad to the summit of a papilla which projects into the lumen of the duodenum from its dorsal wall. The papilla is the enlarged portion of a fold or ridge of the mucosa (plica longitudinalis duodeni) which extends caudalward from the pylorus along the dorsal wall of the duodenum. In a distended condition of the duodenum, the fold is nearly obliterated, but the

papilla remains quite prominent. It is often pinkish, due to the congestion of the neighboring blood vessels, and is frequently bile-stained. The opening, as before stated, is common to both the ductus pancreaticus and ductus choledochus. It is from 2 to 3 cm. from the pylorus.

The Ampulla of Vater.

As the ductus pancreaticus and ductus choledochus approach the duodenum their lumina lose their regular outlines due to the folding of the inner surfaces of their walls. Within the duodenal wall their lumina become still more irregular, and, in the undistended condition, are flattened antero-posteriorly. For a short distance the two ducts remain distinct, being separated by a wedge-shaped band of smooth muscle. Beyond the muscle band the two ducts lose their distinctness and continue as narrowed channels incompletely separated by folds of tissue. These channels open into the ampulla of Vater. The ampulla is likewise irregular in outline, being subdivided by folds of its inner surface. In the undistended condition these folds are arranged as shown in Figs. 6 and 7. In a distended condition the ampulla shows a different appearance. The folds now stretch across the cavity subdividing it into compartments as shown in Fig. 8. The folds thus present the appearance of a distinct valve. They may serve to prevent the contents of the duodenum from entering either duct and do aid in preventing the flow of the bile into the ductus pancreaticus or vice versa. This is shown by the results of injections. A number of unsuccessful attempts were made to inject the pancreatic ducts by introducing the needle of the syringe into the opening of the ampulla. A small quantity of celloidin passed into the ampulla, but none entered the pancreatic duct. It was necessary to break through the folds of the ampulla and have the needle enter the pancreatic duct before successful injection could be obtained. Again several attempts were made to inject the pancreatic ducts by closing the opening of the ampulla into the duodenum and then injecting into the ductus choledochus as Revell did in the case of the dog. Under ordinary pressure no celloidin entered the ductus pancreaticus at all, and under high pressure but very little passed into the pancreatic duct, so that successful celloidin injections could not be made in this way. With fluids, such as water or an aqueous solution of Berlin blue, the same results were obtained. Little, if any, of the fluids entered the pancreatic duct even under high pressure. That the folds are not always present or do not invariably prevent fluids from passing from one duct into the other was shown in one case in which regurgitation of the bile into the ductus pancreaticus had taken place. It is to be regretted that an examination of the ampulla was not made in this case.

The relation of the bile and pancreatic ducts to the ampulla was found to be quite different from that which Gage describes and figures. Beyond the wedge of smooth muscle, the two ducts, as before stated, lose their distinct walls and can be traced into the ampulla as narrow channels between the folds of mucosa. Two distinct ducts in the ampulla, of which the bile duct extends up to within a short distance of the orifice, while the pancreatic opens about the middle of the ampulla, as is shown in Pl. XIV, Fig. 1, of Gage's paper, were not found in any instance.

Ductus Accessorius (Santorini).

(1) Intraglandular Part.—This portion of the duct lies within the pancreas ventral to the axial branch of the caput. Its direction is caudad and to the right, that is, as if it came from the cauda pancreatis. It is from 8 to 15 mm. long and from .4 to .7 mm. in diameter. It receives a varying number of branches which, as a rule, are small. The exact extent of the duct is not easily made out because of the difficulty in determining the point of anastomosis of the duct with the ductus pancreaticus. In some cases the extent of the duct could not be determined because of the fact that at one place the diameter of the ductus accessorius and the branch of the ductus pancreaticus with which it anastomosed was much reduced and increased from this place in both directions. This narrow portion thus marked the boundary of the two ducts. The anastomosis between the ducts is subject to variation. The ductus accessorius may be connected by anastomosis with one of the small branches of a lobar duct belonging to the ductus pancreaticus, or it may be connected by anastomosis with the main stem of a lobar duct instead of with one of its smaller branches. In this case the duct has more nearly the form of a side channel from the main duct to the wall of the duodenum. Again, the branches of the ductus accessorius may anastomose freely with those of a lobar duct giving rise in some instances to quite a complicated network (Fig. 10, IV and V).

(2) Free Part of the Ductus Accessorius.—This is to be sought for on the ventral side of the duodenum, a little caudad to the ductus pancreaticus. The ventral edge of the pancreas overlaps it and conceals its passage to the duodenum. By pushing back the ventral edge of the pancreas and testing the attachment of the latter to the duodenum, a whitish band will be found which is firmly inserted into the wall of the duodenum and which can be traced to the point where it enters the substance of the gland. This whitish band is the free part of the ductus accessorius. It is from 1 to 2 mm. long and about .5 mm. in diameter. Its course toward the duodenum is usually at right angles to its wall.

(3) Duodenal Part of the Ductus Accessorius.—This measures from 1.5 to 2.5 mm. long. Its course through the wall of the duodenum is not in any constant direction, but is in some cases at right angles to the longitudinal muscle coat, in other cases directed either caudad or cephalad. On reaching the mucosa the duct usually enlarges somewhat in diameter. It opens into the duodenum at the papilla duodeni. This is situated 5 to 12 mm. caudad to the opening of the ductus pancreaticus and from one-fourth to one-third of the distance around the intestine to the left. In 3 cases the opening was at the same level as that of the ductus pancreaticus. The papilla duodeni is frequently very indistinct in fresh material,

but more prominent in material hardened in alcohol. This papilla is the slightly enlarged portion of a fold which extends from the pylorus caudad, running parallel to the plica longitudinalis duodeni. The opening can often be found by running a seeker along the fold toward the pylorus. The fold is, like the papilla, often indistinct and sometimes absent. From these facts it is seen that the determination of the position of this opening is often somewhat difficult. The best and surest way to find its location is to inject some thin mass into the ductus pancreaticus and force it around through the ductus accessorius so that it flows into the duodenum.

Note on the ductus accessorius.—Within the wall of the duodenum the duct loses its distinct wall although still lined by a layer of epithelium. The mucosa dips down between the muscle coats and the duct and is abundantly provided with glands which open into it. In the mucosa an enlargement of the duct usually occurs, this enlargement corresponding in some degree to the ampulla of Vater. Cross and longitudinal sections of the duodenum show that this part of the duct is subdivided by folds of the mucosa. In two cases, one of longitudinal sections, the other of cross-sections of the duodenum through the duct a reservoir was found in the mucosa which had a distinct epithelial lining and which was in connection with the ductus accessorius (Fig. 9). As these were the only two cases in which serial sections were made, its significance and the frequency of occurrence were not determined.

Communications between the Ducts.—Due to its small size and also probably to the thickness of the injection mass, the ductus accessorius was not injected in every instance. In a number of cases the duodenal part of the ductus accessorius was not injected. Whether this was due to the contraction of a sphincter muscle around the duct or to the atrophy of this part of the duct was not determined.

In the large majority of cases both the ductus pancreaticus and ductus accessorius were completely injected. A study of these showed that the communication between the two ducts is subject to great variation. All cases examined, however, could be reduced to one of four types (Fig. 10, I, II, III, and IV). In the first type the ductus accessorius communicates by anastomosis with a single branch of a lobar duct belonging to the axial branch of the caput. In the second type the anastomosis is single as in the first, but the lobar duct joins the axial branch of the cauda. In the third type several anastomoses are formed between the branches of the ductus accessorius and lobar duct, the lobar duct joining the axial branch of the caput as in type I. In the fourth type the number of anastomoses is greater than in the third, the lobar duct joining the axial branch of the cauda as in type II. Of the four types, type I was most frequently found and for this series may be called the normal. Fig. 10, V, shows how freely the branches of the ductus accessorius and those of a lobar duct may anastomose with one another. The variation in the communication between the two ducts indicates that, in a larger number of specimens, other types might be met with.

Remarks.—Variations in the shape of the pancreas were quite frequent and, as far as noted, were confined exclusively to the caput and to the strip of glandular tissue between the caput and cauda.

Of the five types of pancreatic anomalies described by Ruediger in man, none were found which exactly corresponded in the cat. Two cases of pancreatic anomalies, however, were met with. In the first case, a band of glandular tissue, apparently an outgrowth from the caput, passed cephalad, following the ductus choledochus and cystic duct and partly covering them on their ventral side. It extended to about the middle of the gall bladder, where it fused with the connective tissue around the latter. It had a duct which passed down its entire length and joined the axial branch of the caput. In the second case, Fig. 11, a similar though slightly narrower band of glandular tissue extended from the caput alongside the ductus choledochus and cystic duct. It then continued along the left side of the gall bladder to the posterior part of the liver, where it enlarged into an oval nodule about 1 cm. in its long diameter. This nodule occupied a hollow in the right central lobe of the liver to the left of the gall bladder. A duct was present which extended from the nodule down the middle of the band, joining the axial branch of the caput as in the previous case.

These two cases suggest an explanation of the formation of the pancreatic bladder, six cases of which have been reported by Miller. In the first case the strip of pancreatic tissue has not extended so far from the body of the pancreas and may be considered as an intermediary stage represented in completed form by case two. In both cases a duct was present. If in case two, one imagines the persistence of the duct with a bulbous dilatation of that portion of it contained in the nodule of pancreatic tissue and atrophy of the glandular substance, he will have a pancreatic bladder similar in every way to those which have been described.

With regard to the relation of the ducts to the gland, it will be seen that there is necessarily a close correspondence between the form and size of the ducts and the shape and lobulation of the gland. Thus the gland is long and so are the axial or main branches. The gland is narrow and consequently the lobar ducts are, as a rule, short. An exception to the latter statement occurred in four or five cases in which distinctly long lobar ducts were present. They appeared especially in the cauda and ran more nearly parallel to its axial branch than the other lobar ducts. The dichotomy of their branching was also less apparent and they resembled more nearly the axial ducts.

Of the five varieties of abnormalities of the excretory ducts described by Sappey in man, namely, (1) the accessory duct of Santorini entirely absent; (2) the duct of Santorini the main excretory duct; (3) the ductus pancreaticus not passing through the ampulla of Vater, but opening into the duodenum independently; (4) the presence of two excretory ducts of about equal size which run parallel to each other throughout the entire length of the gland, and (5) the presence of three excretory ducts, no distinct case was found in the cat. The

FIG. 1.—The coils of the intestine have been removed so that there remains only the duodenum and a small portion of jejunum and the rectum. The entire pancreas is seen in its normal position. The right limb is attached to the duodenum and extends down to the pars horizontalis. The left limb runs across the abdominal cavity posterior to the stomach. It lies ventral to the left kidney and its tip covers the left ovary on its ventral side. The spleen does not occupy its normal position but has been drawn forward by the displacement of the stomach. The right ovary lies in this case ventral to the pars decendens of the duodenum. In the posterior part of the drawing are seen the furrows in the fat mass occupied by the coils of the intestine.

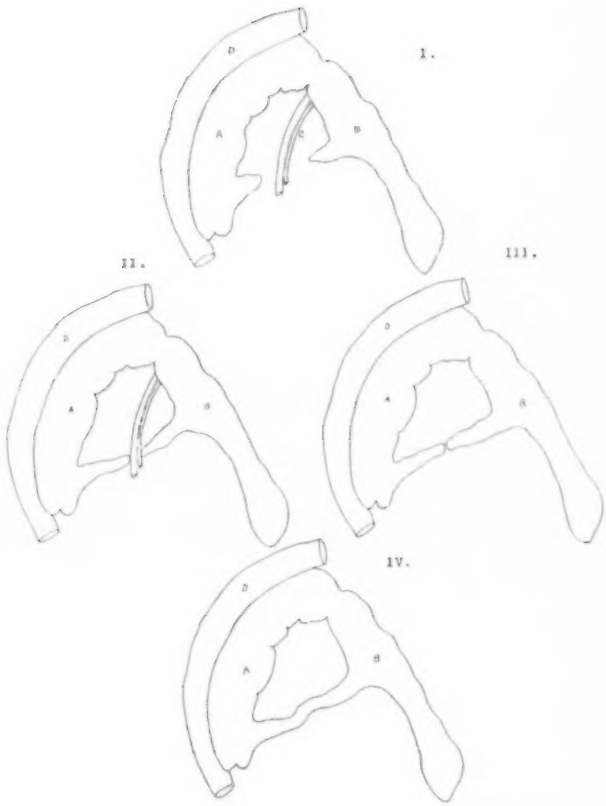

FIG. 3.—Semidiagrammatic drawings to show the formation of the bridge. As is stated in the text, five cases of such incomplete formations were met with. In I a spur of tissue from both caput and cauda is approaching the blood vessels (superior mesenteric artery and vein). In II the two spurs have reached the blood vessels. In III the two spurs are almost in contact and between them there has formed a narrow bit of tissue. In IV the fusion between the spurs is complete and the bridge is formed. The fusion of the two spurs takes place dorsal to the blood vessels. *A*, caput pancreatis; *B*, cauda pancreatis; *C*, superior mesenteric artery and vein; *D*, portion of the duodenum.

FIG. 2.—The pancreas from an animal fixed with formalin and drawn in its normal position, from its ventral aspect. *A*, caput pancreatis; *B*, cauda pancreatis; *C*, bridge of tissue connecting caput and cauda; *D*, groove along which the pancreas is applied to the duodenum.

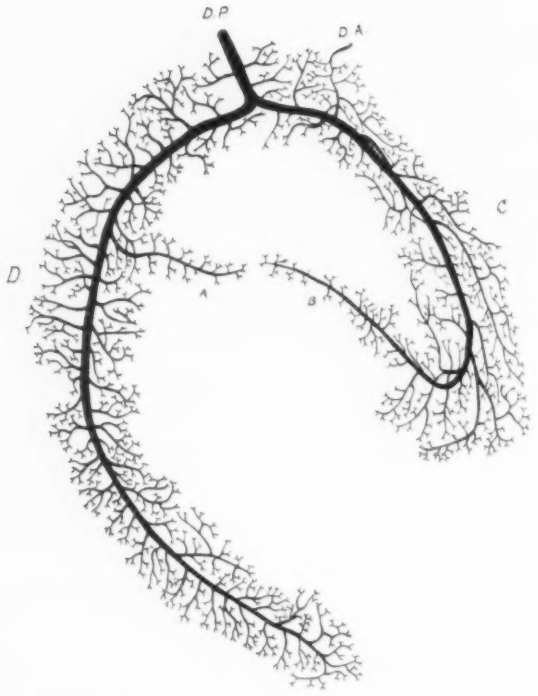

FIG. 4.—The pancreatic ducts in the cat. Drawn from a corrosion preparation. Dorsal view. *DP*, ductus pancreaticus (Wirsungiania); *DA*, ductus accessorius (Santorini); *C*, axial branch of the caput pancreatis; *D*, axial branch of the cauda pancreatis; *A* and *B*, branches of the bridge of the pancreas.

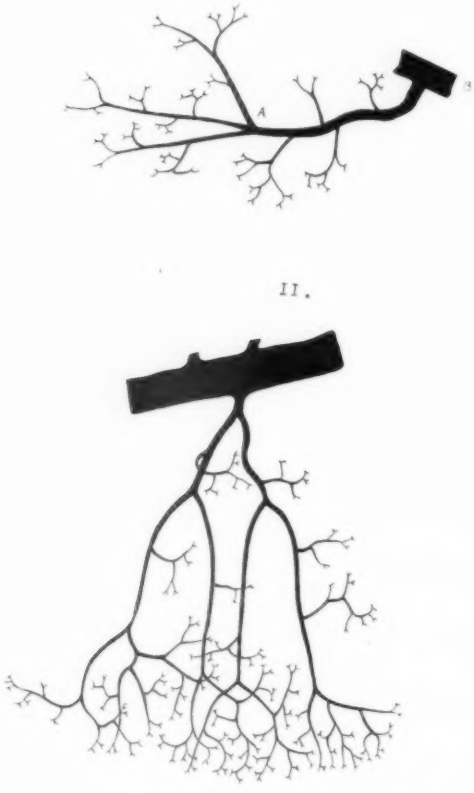

FIG. 5.—I. A lobar duct showing three branches, all lying in different plains, joining at the common point *A*. *B*, axial duct. II. A lobar duct showing dichotomous branching throughout. Usual type.

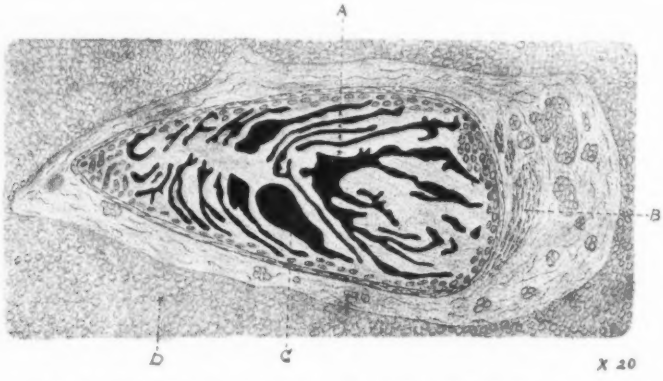

FIG. 6.—Transverse section of the ampulla of Vater. The ampulla was injected under low pressure with blue gelatin which filled the spaces between the folds of the ampulla represented by solid black in the figure. The section is the same as one which would be obtained if it were cut along the line *mn* in Fig. 7. *A*, folds in the ampulla; *B*, smooth muscle; *C*, space between the folds; *D*, glands of the mucosa.

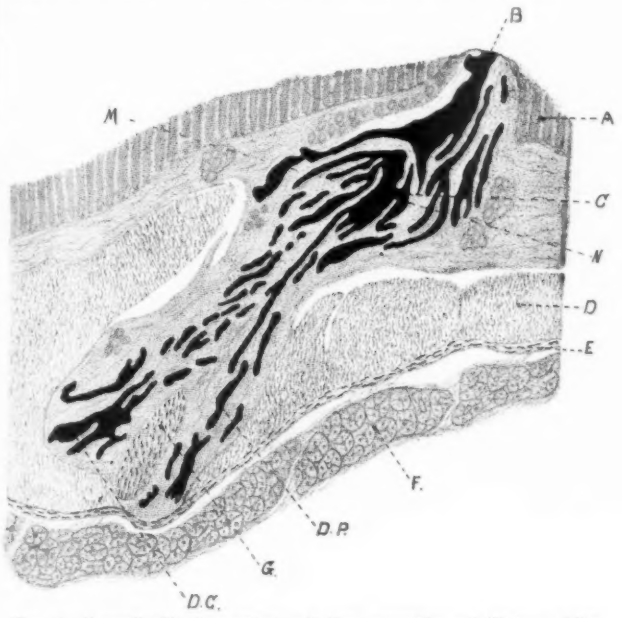

FIG. 7.—Longitudinal section of the ampulla of Vater. The ampulla was injected with blue gelatin as in Fig. 6. *A*, glands of the mucosa; *B*, opening of the ampulla of Vater into the duodenum; *C*, ampulla; *D*, circular muscle coat; *E*, longitudinal muscle coat; *F*, lobule of the pancreas; *DP*, ductus pancreaticus showing its opening into the ampulla; *DC*, ductus choledochus cut along one wall showing outfoldings filled with blue gelatin. By these the continuation of the ductus choledochus into the ampulla can be traced; *G*, wedge of smooth muscle between the ductus pancreaticus and ductus choledochus.

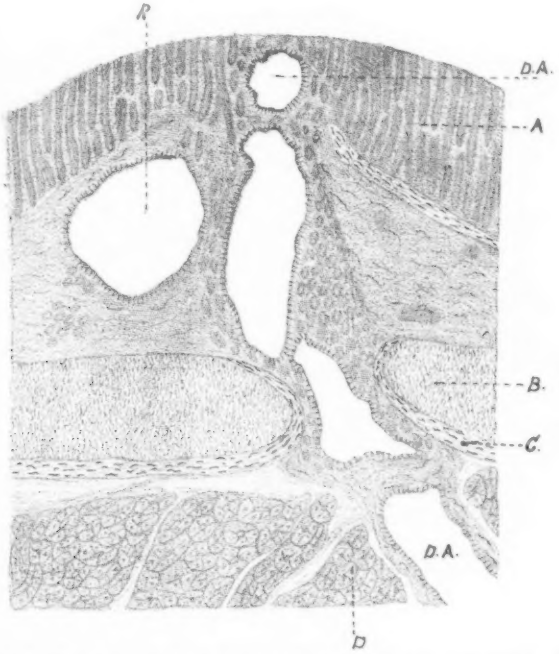

FIG. 9.—Section of the duodenal wall showing the duodenal portion of the ductus accessorius in longitudinal section. *A*, glands of mucosa; *DA*, ductus accessorius. The duct had a slightly tortuous course which makes it appear discontinuous in section.; *B*, circular muscle coat; *C*, longitudinal muscle coat; *D*, lobule of the pancreas; *R*, reservoir having a distinct epithelial lining. This reservoir opened into the ductus accessorius.

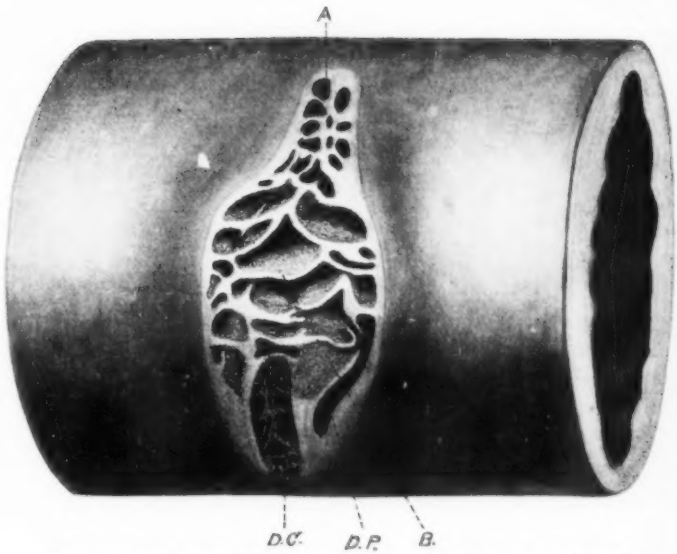

FIG. 8.—Drawing showing the ampulla of Vater in a distended condition. The opening of the ampulla into the duodenum was closed and then the ampulla was injected with celloidin under high pressure. After hardening in alcohol, the dorsal wall of the ampulla was removed and the celloidin carefully picked out of the spaces between the folds. *A*, position at which the ampulla opens into the lumen of the duodenum; *B*, folds subdividing the cavity of the ampulla into compartments; *DC*, ductus choledochus; *DP*, ductus pancreaticus.

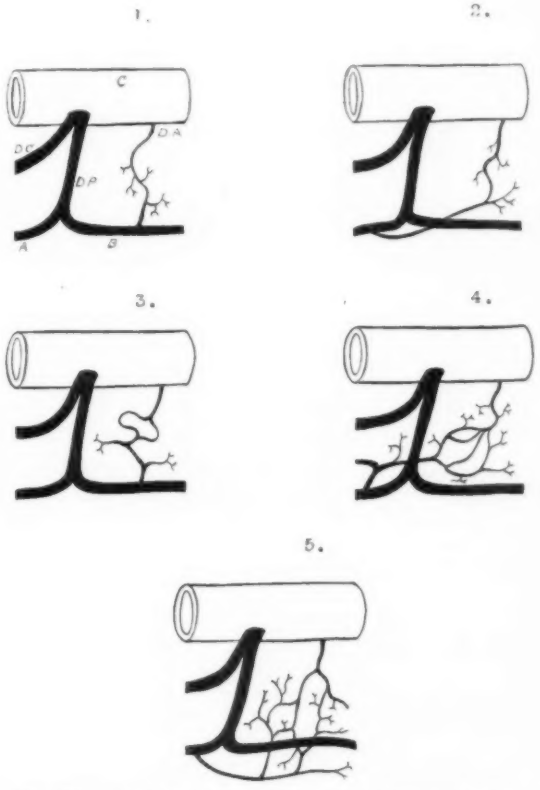

FIG. 10.—Diagrams showing the types of communications between the ductus pancreaticus and ductus accessorius. The same lettering applies to all of the diagrams. *A*, axial branch of the cauda pancreatis; *B*, axial branch of the caput pancreatis; *DC*, ductus choledochus; *DP*, ductus pancreaticus; *DA*, ductus accessorius; *C*, portion of the duodenum.

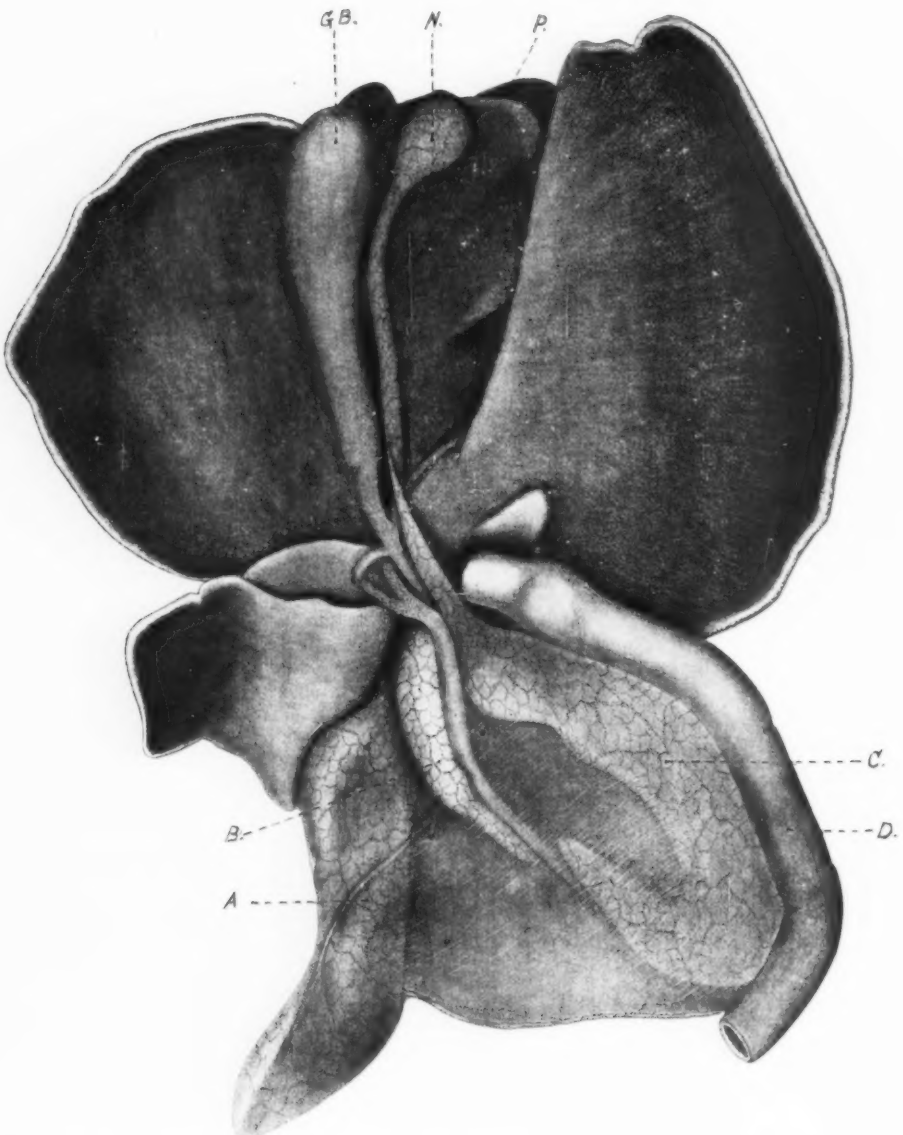

FIG. 11.—Drawing showing an anomaly in the pancreas. The duodenum and pancreas have been turned over to the left side so that their dorsal surfaces are seen. The strip of tissue *P* extends cephalad, terminating in the nodule, *N*. *GB*, gall bladder; *N*, nodule of pancreatic tissue; *P*, strip of pancreatic tissue; *A*, cauda pancreatis; *B*, arm of pancreatic tissue; *C*, caput pancreatis; *D*, portion of duodenum.

ductus pancreaticus was in every instance the larger, the ductus accessorius the smaller duct. The ductus pancreaticus in every case passed through the ampulla of Vater. The only resemblance to any of the varieties was one case in which two ducts of about equal size were present in the caput. They ran parallel to each other and joined the axial branch of the cauda at a common point. This case resembles variety four of Sappey.

The relation of the blood vessels to the ducts was found to be in general the same as Revell described in the dog. The artery (arteria pancreatico-duodenalis superior) runs caudad in the caput between the axial duct and duodenal wall. In its course it passes between the ductus pancreaticus and ductus accessorius, showing that the two or three pancreatic buds grow out and fuse over the blood vessel.

A comparison of the ducts as found in the cat with the normal ducts in other mammals, as man and the dog, shows a considerable variation. In the cat the ductus pancreaticus is the larger and opens into the duodenum with the ductus choledochus; the ductus accessorius is the smaller and opens into the duodenum independently a short distance caudad to the ductus pancreaticus. In man the ductus pancreaticus is the larger and opens into the duodenum with the ductus choledochus as in the cat; the ductus accessorius is the smaller but opens into the duodenum anterior to the ductus pancreaticus. In the dog the ductus pancreaticus is the smaller and opens into the duodenum with or immediately caudad to the ductus choledochus; the ductus accessorius is the main duct and opens into the duodenum caudad to the ductus pancreaticus.

In conclusion I wish to express my obligations to Dr. W. S Miller, under whose direction the work was done.

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ON THE SCHULTZE CLEARING METHOD AS USED IN THE ANATOMICAL LABORATORY OF THE JOHNS HOPKINS UNIVERSITY.

BY EBEN C. HILL.

Before the invention of the microtome, the earlier embryologists studied embryos by gross dissection, and it naturally followed that they compared their dissections with those of the adult. Such a procedure often gave excellent results as may be seen in the great work of von Baer. Many questions, however, could not be answered by this relatively crude method, and it was not until sections of hardened embryos were made that more satisfactory results were obtained. Then followed methods by which very thin sections were easily made by the thousand and for a time it appeared as if what was studied with the microscope could not be brought into relation with our knowledge of human anatomy. However, this difficulty was soon overcome by His, who by graphic reconstruction combined numerous sections and thus demonstrated the relation of organs and tissues of the smallest embryos. This method was soon improved by Born, who substituted wax plates for the primary drawings of His, and thereby made concrete wax models on an enlarged scale. This method has been extensively used in this laboratory as well as elsewhere.

For sometime, however, there has been a tendency to abandon these slower reconstructive methods which present so many possibilities for error in the histological technique and in the subsequent construction of wax models, and to adopt instead such methods as will especially emphasize by staining and clearing reagents those tissues and systems which are under investigation. Besides the saving of time and energy, and the lessening of the chances for inaccuracy in interpretation and technique, Dr. Mall informs me that in the case of certain tissues these differential methods of staining and clearing give results which can be obtained by no other means. For instance, in the study of the cranial ossification centers of human embryos, Dr. Mall found that these centers were clearly demonstrated by staining and clearing at times when

the ordinary histological methods gave no evidence of this ossification.

Schultze Method.—Schultze, in 1897, was the first to advocate the use of potassium hydroxide as a method for demonstrating the development of the skeletal cartilages, though, as he points out, Beale in 1853 and later Theodore Koelliker made use of this reagent to render transparent the softer tissues of embryos. Schultze advises that embryos ranging from five to ten centimeters in length be placed for from three to eight days in 95 per cent alcohol which should be frequently changed. Then follows a treatment with a 3 per cent aqueous solution of potassium hydroxide, which may be renewed on the following day. When the skeletal cartilages are apparent the specimen is placed in 25 per cent glycerine to which a small amount of .5 per cent formalin has been added in order to prevent the growth of moulds. A greater percentage of formalin tends, he says, to harden the embryo and cause opacity. Larger embryos receive the same treatment except that openings are made into the abdomen, thorax, and cranium so as to permit free access for the reagents. By following these methods of procedure, specimens demonstrating the development of the bones are easily obtained, but the best results may be had, he suggests, by the use of a 3 per cent alcoholic solution of potassium bichromate followed by treatment for several days with 95 per cent alcohol. The specimens are then placed in a mixture of one-third pure glycerine, one-third concentrated potassium hydroxide, and one-third distilled water; or equal parts of pure glycerine and concentrated potassium hydroxide may be used. Upon clearing, the bones appear brown. Schultze suggests the possibilities of injections of cinnabar but does not mention any results that he has obtained from such injections.

Van Wijhe Method.—In 1902 Van Wijhe published a method for demonstrating the development of the skeletal cartilages which differed materially from that of Schultze. His method depends upon the well-known quality of cartilage to retain aniline stains. Van Wijhe advocates 5 per cent sublimate solution, 10 per cent formalin or Zenker's fluid for fixing the specimens, after which they are placed in alcohol (percentage not given but presumably 95 per cent) in which is a trace of hydrochloric acid. The specimens are then placed in an alcoholic solution of methylene blue to which 1 per cent hydrochloric acid has been added; (one-quarter gram of methylene blue in 100 cc. of 70 per cent alcohol). After staining, the intensely blue objects are treated with 95 per cent and 70 per cent acid alcohols alternately, until there is no longer any trace of stain in the alcohols. So resistant is this aniline stain to the action of acid alcohols that specimens may remain a year or more in these media without the cartilage losing its stain. The objects are removed to absolute alcohol until completely dehydrated and are then placed in a mixture of two parts absolute alcohol and one part xylol. After this they are placed in a mixture of one part absolute alcohol and two parts xylol, which is then followed by pure xylol. They may then be permanently mounted in Canada balsam of a melting point of 60° C.

Lundvall Method.—Two years after the publication of this method Lundvall in his article treating of the staining and clearing of embryonic skeletal cartilages commends Van Wijhe's method for small objects, but pronounces it to be useless for larger specimens. He reiterates the advice of Schultze about removing the brains and viscera before proceeding with the clearing, and advises against the use of certain of the reagents which Van Wijhe especially recommends.

His method, in brief, is to fix the specimens in 10 per cent formalin for at least forty-eight hours. They are then placed in 95 per cent alcohol for a similar length of time, after which they may be stained in toluidin blue. This stain Lundvall considers is far superior to methylene blue in cases of medium-sized and large objects, maintaining that its action is more rapid and that the stain produced is more intense. This staining fluid is composed of .25 g. of toluidin blue in 100 cc. of 70 per cent alcohol which contains .5 per cent hydrochloric acid. Then add .5 cc. of hydrochloric acid and after standing twenty-four hours, filter. To obtain the best staining, specimens should be placed in this solution in a thermostat at 40° C. for one day. As suggested by Van Wijhe, the success of the decoloration is best assured if 95 per cent and 70 per cent acid alcohols are used alternatively. Canada balsam and xylol Lundvall contends are useless because, according to his experiments, the specimens are rendered cloudy. So after removing the stain from all of the tissues except the cartilage he places the objects in 95 per cent alcohol for a day or so, and then removes them to absolute alcohol in which are placed a few crystals of copper sulphate to guard against the presence of water. After two days of dehydration the specimens are removed to a mixture of one part benzol and two parts absolute alcohol for from twelve to twenty-four hours, are then removed to a mixture of two parts benzol and one part absolute alcohol for twice that length of time, and are later placed in pure benzol. Finally they may be indefinitely preserved in carbon bisulphide. On account of the high refractive index of this preserving fluid the specimens should not be placed for study in round tubes or jars. Four-sided vessels are preferable, and to avoid the dangers of evaporation or explosion the tops should be held in place with sodium silicate.

Uses of Clearing Methods.—In the anatomical laboratory of the Johns Hopkins University the advantages of a method which would obviate the tedious cutting of sections and modeling and would in the end give the real object in its natural relations instead of an imitation, were readily appreciated, and since the first appearance of this article by Schultze, experiments in staining, injecting, and clearing have been carried on. The methods advocated by Van Wijhe and Lundvall have not received as much attention as the earlier method because of their more recent appearance and because

the older method has been so perfected that it meets all of the requirements.

Schultze is the only one of the three who has hinted at the possibilities of the clearing method for other than the investigation of bone, and in his communication he does not mention any results that he has obtained from injections or partial clearings. Van Wijhe and Lundvall advocate their methods solely for cartilage and do not indicate any other uses to which they may be put. In reality this study of the skeletal system is but one of the many embryonic investigations which are greatly facilitated by clearing methods. The one objection to the use of the Schultze method for other than resistant bony tissue has been its unreliability. At times beautifully cleared specimens of the arterial and lymphatic systems were obtained by following one of the three procedures outlined by Schultze, but the uncertainty of obtaining good results and the possibility of destroying valuable material have kept it from gaining the popularity which with its present modifications it now deserves. These modifications have been introduced after many experiments in injecting, staining, and clearing human embryos and embryo pigs, and at the present time with reasonable care no specimen should be injured.

Before discussing the changes which it has been necessary to introduce into this method it may be better to first consider the uses to which it has been applied in this laboratory. On account of the large numbers of uteri of pregnant swine which are delivered each day immediately after removal, injections and clearings have been made which have greatly simplified the study of the development of the arterial, venous, lymphatic, and other tubular systems.

By staining and clearing human embryos Dr. Mall has demonstrated the earliest appearance of the ossification centers in the skeletal system. Injections which were subsequently cleared have shown the development of the vascular system of the brain,[10] the lymphatics of the intestines, the superficial lymphatics of the skin,[11] the semicircular canals, the arterial supply to the Wolffian body and kidney,[12] and the bile-ducts of the liver.[13]

Method of Injections.—In all of the problems except that of the development of the bone and cartilage the procedure has been essentially the same. There must be an injection fluid which will not distort the tissues by its chemical action or by the force necessary to cause its entrance into the ducts and capillaries. This fluid must also be unaffected by those reagents which are to render the tissues transparent. India ink furnishes such a medium and this has been the fluid which has been used in nearly all of the injections. Heuer, by injections into the thoracic duct and into the mesentery of embryo pigs followed by clearing the specimens according to the Van Wijhe or Schultze methods, succeeded in demonstrating the development of the lymphatics in the small intestine. In investigations of the respiratory system injections into the trachea with India ink were found upon being cleared to fill the alveoli of the lungs of a 30 mm. pig. By injections into the stomach the bile capillaries of the liver have been demonstrated in the 100 mm. stage, and have been traced in this manner until the time of birth. In this case the stomach acted as a pressure bag and the injection mass after a short interval was seen to fill the gall-bladder, and its subsequent course through the bile-ducts and capillaries could be followed by noting the darkened areas. So constant was the pressure maintained by this method that upon microscopic examination few areas of extravasation were found, and yet in almost all of these experiments the pressure was sufficient to force the injection into the œsophagus as well as through the loops of small intestine into the colon and later out of the rectum. Upon clearing the entire embryos, very instructive specimens were obtained. Injections into the urinary bladder demonstrate the uriniferous tubules of the kidney and Wolffian body. So far attempts to inject and clear the pancreatic ducts have not proved to be especially fruitful. Injections of the spinal canal gave beautiful pictures if the injection fluid was started from one of the ventricles of the brain.

The relations of the arterial and venous circulations in the placenta may be readily made out by injections into the umbilical arteries or vein. Upon ligation of the placental end of the cord and after a ligature has been passed around the body of the embryo just posterior to the heart, an injection into either of the umbilical arteries results in an arterial injection of the abdominal vessels as well as of those of the hind legs, which upon being cleared by the Schultze method demonstrate not only the larger vessels but even the small nutrient arteries of the bones. Because of the ductus arteriosus the ligature around the body of the embryo at the position indicated is essential to prevent an injection of both the arterial and venous systems. If small embryos are still alive when brought to the laboratory, as frequently happens, injections into the liver direct are soon forced to the heart which pumps the fluid through the entire arterial system.

In making the injections India ink diluted to one-third of its commercial strength has been used. The use of distilled water for injections at times causes a precipitation, but this may be easily remedied by the addition of a small amount of weak ammonia. Lamp-black solutions have proved to be most unsatisfactory because of the difficulty of obtaining solutions of similar consistency. Frequently also this injection-mass clogs the needle of the hypodermic syringe. The injections of the smaller embryos are carried on in warm water with the membranes still intact.

Clearing.—After the injections have been completed all unnecessary tissues surrounding the parts under investigation are removed and the specimens are placed in 95 per cent alcohol. The removal of this adventitial tissue is most important, though entire embryos may be successfully cleared if openings are made into the abdomen, thorax, and cranium. In large embryos ranging above 15 cm. it is still better to make sagittal sections of the hardened specimens and clear in halves The alcohol should be frequently changed and large quantities should be used. In order to obtain transparent specimens

the tissues must be completely shriveled before removal from the alcohol, and the length of time necessary to accomplish this result depends, of course, upon the size of the objects. For very small specimens at least three days should be allowed while for large objects the time should not be less than one week. Experiments with absolute alcohol instead of 95 per cent alcohol gave no better results and its use is an unnecessary expense. The coagulation of the proteids occurs almost as rapidly in one percentage as in the other.

After the specimens have been sufficiently shriveled they should be placed in 1 per cent potassium hydroxide. When a higher percentage is resorted to, so rapid is the action that the safety of the specimen is endangered, and it was the use of the strong solutions advocated by Schultze which caused the loss of much valuable material. In this weaker solution the tissues become transparent in from four to forty-eight hours, depending upon the size of the objects. From this medium they should be transferred to 20 per cent glycerine in which clearing continues and a certain amount of hardening occurs, rendering the tissues firm enough to permit of dissection. Should the specimens be as transparent as is desired, they may then be transferred from time to time to higher percentages of glycerine till at last they are permanently stored in pure glycerine. A certain amount of shrinkage is noticed in some organs after an immersion in this fluid for a year or more, but when the specimens are studied immediately after being cleared the measurements are the same as in the fresh tissue. We have also found that embryos hardened in formalin can be cleared in 10 per cent potassium hydroxide in the course of several weeks or months. However, in order to show the ossification centers the specimens are not to remain in the formalin solution very long for it decalcifies the bone.

Blood pigment in all cases will not be removed entirely by this process alone and in organs such as the kidney transparency can sometimes be obtained only by a secondary treatment. After passing through the 1 per cent potassium hydroxide and being placed in the 20 per cent glycerine as outlined above, the specimens containing the objectionable pigment are treated with a mixture of equal parts of 50 per cent ammonium hydroxide and 1 per cent potassium hydroxide. In this solution there is comparatively little danger to the specimens as the hardening produced by the 20 per cent glycerine clearing reagents. Indeed, in cases where it is deemed advisable to stop the clearing action or for any reason it is found to be more convenient to continue the process at some future time, the specimens may be removed to this 20 per cent glycerine and retained in this medium until a more fitting time when much higher percentages of caustic solution may be resorted to without danger to the objects.

Method of Staining and Clearing the Skeletal System.—In demonstrating the development of the skeletal system Dr. Bardeen advocated the use of alum-cochineal in place of the stains advised by Schultze, Van Wijhe, and Lundvall. The specimens are placed, without previous fixing in formalin, in 95 per cent alcohol until shriveled. Then follows staining for twenty-four hours in alum-cochineal, after which they are cleared in the 1 per cent solution of potassium hydrate. Embryos treated in this way give beautiful specimens with the bone stained red.

Mounting Specimens.—Until recently the method of Van Wijhe had the advantage of permanently mounting the specimens in Canada balsam, which seems impossible in cases of tissues cleared with potassium hydroxide, but Bardeen has devised a method by which specimens may be mounted upon glass slides and placed in any desired position in jars of glycerine. This method, in brief, is to remove the specimens from pure glycerine, wipe, and quickly wash. They are then placed in a little thick gelatin solution and are laid upon a warm glass slide. As soon as the gelatin is hardened the specimens are returned to the pure glycerine without any danger of coming off. The purity of the glycerine should be assured, else the presence of foreign substances, such as water, may tend to soften the gelatin.

Summary.

1. Specimens are placed in 95 per cent alcohol until completely shriveled. Three to seven days.

2. Are then removed to 1 per cent KOH until transparent. Four to forty-eight hours.

3. Placed in 20 per cent glycerine for forty-eight hours or more.

4a. If cleared, place at intervals of two or three days in ascending percentages of glycerine.

4b. If not clear, place in equal parts of 1 per cent KOH and 50 per cent ammonium hydroxide for five to seventy-two hours. Then place in 20 per cent glycerine for forty-eight hours or more, and continue treatment as outlined in 4a and 5.

By following this method the systems of bones, cartilages, arteries, veins, lymphatics, and various ducts can be demonstrated with a transparent embryo or with large sections of adult tissue without any distortion of the structures.

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ON THE EMBRYONIC DEVELOPMENT OF A CASE OF FUSED KIDNEYS.

By Eben C. Hill.

(From the Anatomical Laboratory of the Johns Hopkins University.)

At an autopsy recently held at Bay View Asylum in Baltimore, Dr. Bunting discovered an interesting case of fused kidneys which he kindly allowed me to study. Although this anomaly is by no means infrequent, the manner of fusion of the two organs and the relative positions of the ureters and blood vessels so clearly emphasized certain developmental conditions that a short description and an attempted explanation is permissible.

History of Case.—It was demonstrated at the autopsy that death was not due to fusion of the two kidneys, though certain pronounced lesions were found which indicated nephritis. Indeed, no cases are recorded in the autopsies of the Johns Hopkins Hospital where fusion of these organs has caused death. The kidneys seem quite as capable of properly functioning when fused and misplaced as when normally developed and located.

Extracts have been taken from those sections of the autopsy report which in any way apply to the location and arterial supply of this anomaly and its possible pathological effect on the surrounding tissues and organs.

Autopsy No. 2465. James C. Aet. 28 years. Autopsy by Dr. Bunting.

Anatomical Diagnosis.—Congenital malformation of kidney, chronic nephritis, cardiac hypertrophy and dilatation; general anæmia of organs; disseminated tubercles in liver.

Abdomen.—The peritoneal cavity is negative, no excess of fluid, and no adhesions.

Thorax.—The pericardial cavity is free from adhesions or from excess of fluid. The surfaces are smooth and glistening throughout. The heart is large, the hypertrophy being most marked in the left ventricle. The right side is dilated. Over the right ventricle there are one or two areas of thickening and opacity in the epicardium which are irregular in size and shape.

Heart.—The right auricle is practically free from clot, and is slightly dilated. The tricuspid orifice easily admits the tips of four fingers. The tricuspid valve is delicate and normal. The pulmonary valves also are delicate and normal. The right ventricle is somewhat dilated, its wall is not especially hypertrophied, averaging 5 to 6 mm. in thickness. The left auricle is somewhat dilated and has a hypertrophied wall. The mitral valve shows very slight thickening along the line of closure, has a fairly delicate free edge. The left ventricular wall is considerably hypertrophied, varying from about 22 mm. at the base to about 12 mm. at the apex of the heart. The papillary muscles are well formed, rounded, and show minute fibrous plaques of translucent greyish color. The muscle of the left ventricle is firm, rather pale, showing a few streaks, apparently of increase in connective tissue about the vessels. The aortic valves appear normal, and show no thickening, and are apparently competent. The coronary vessels are free throughout and show no sclerosis. The base of the aorta is practically free from sclerosis. The foramen ovale is open as an oblique slit. Apparently, functionally, it is closed.

Lungs.—Left lung shows a smooth and glistening pleura which is very pale in color, and which shows numerous emphysematous vessels, especially over the posterior portion of the upper lobe and some depressed areas in the posterior part of the lower lobe. On section the lung has the same pale, greyish-pink color, is quite dry except in the dependent portions, where it is somewhat congested and somewhat more moist. There is a slight yellowish cast to the cut section. The lung is apparently air-containing throughout, and feels somewhat more elastic than the normal lung. The right lung resembles the left. It also resembles the left on section, being particularly dry.

Spleen.—Measures 11.5 x 7 x 4 cm., and weighs 170 gm. The capsule is but slightly thickened and somewhat opaque,

and shows beneath it a rather dark greyish-purple organ which feels softer than normal. On section there is slight thickening of the trabeculæ. The Malpighian corpuscles are large, but distinctly visible. The pulp is slightly increased in amount; however, it does not scrape off easily with the knife, and does not obscure the architecture of the organ. It has a slightly rusty tint.

Liver.—Measures 27 x 20 x 9 cm., and weighs 1970 gm. The surface is uniform and of a dark purple color except for three small nodules which are of a bright yellow and which lie over the middle part of the right lobe. The edge is sharp and straight, and the surface is smooth. The cut surface shows a dark brownish organ which is distinctly cloudy, and shows one or two areas of localized congestion. In general the central veins are but slightly congested, the parenchyma of the organ being brownish-yellow in color. The peripheries of the lobules are not distinctly marked out. The light yellow areas mentioned are found, on section, to be caseated masses resembling tubercles and with concentric arrangement of tissue about their periphery. The gall-bladder contains a thick greenish bile. Bile-ducts are patent.

Stomach.—Contains a large amount of greenish fluid and also some clot of milk. The mucous membrane is very pale, and has a slightly mammillated appearance toward the pyloric end. The rugæ are well marked.

Pancreas.—Is of a good size, somewhat pale, but appears normal.

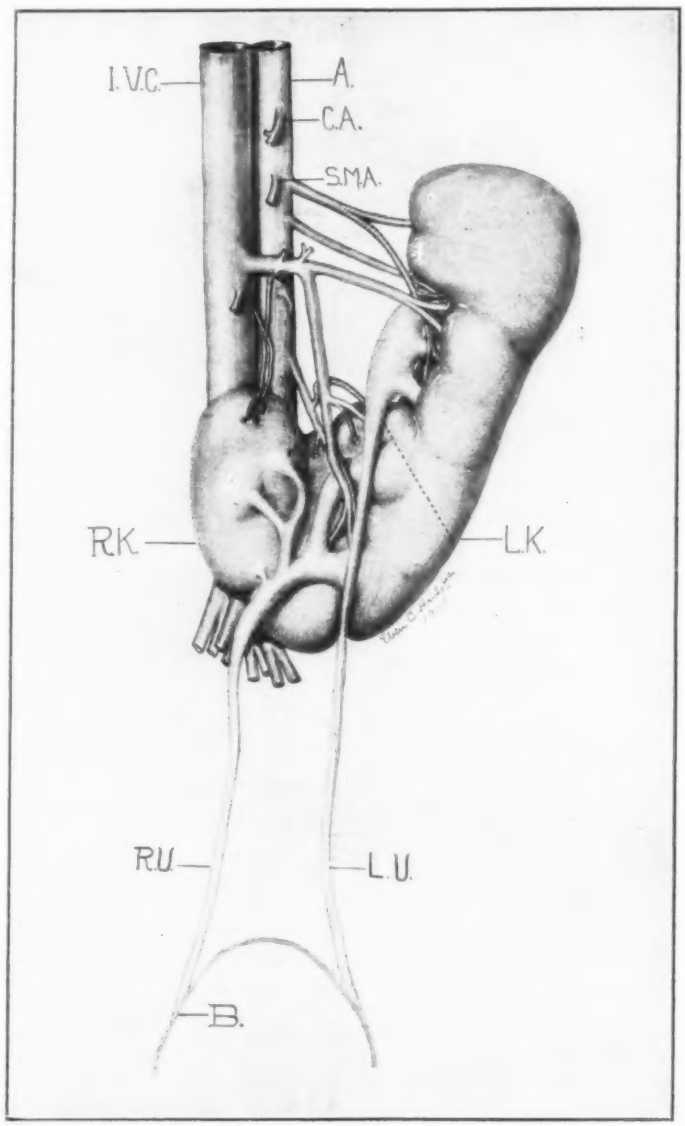
Bladder.—Is very pale, but otherwise appears normal.

Prostate.—Appears normal.

Intestine.—Is free from lesions throughout, and rather pale.

Microscopical Notes—Heart.—The muscle fibers are all extremely hypertrophied, many of them contain large, swollen nuclei. There is an increase in the cells of the interstitial tissue. The stroma is also quite œdematous.

Kidneys.—Show marked degeneration of the epithelial tubules, many of which are compressed or have entirely disappeared. Those remaining are chiefly dilated, show a granular epithelium, and contain granular detritus and numerous hyaline casts. The glomeruli are clumped close together and are in the main in various stages of hyaline obliteration. There is very marked increase in the interstitial tissue which is firm and fibrous.



DESCRIPTION OF THE FIGURE.

Fused kidneys. *A.*, aorta; *I. V. C.*, inferior vena cava; *C. A.*, cœliac axis; *S. M. A.*, superior mesenteric artery; *R. K.*, right kidney; *L. K.*, left kidney; *L. U.*, left ureter; *R. U.*, right ureter; *B.*, bladder wall. Point of fusion of two kidneys indicated by dotted line.

Macroscopic Description of Kidneys.—The left kidney is found in nearly its normal place but there is an L-shaped mass of kidney substance extending from just beneath the diaphragm in the left hypochondriac region about 16 cm. to just above the brim of the pelvis and then crossing the spinal column, the transverse portion measuring about 9 cm. The ureter from the upper portion of the kidney extends over the mass and crosses the iliac vessels about 5 cm. to the left of the median line, crosses the mid-line at the brim of the pelvis, and runs to the right side of the bladder. Both ureteral orifices are easily probed, and are apparently patent throughout and normal in position.

After fixation the fused kidneys show an L-shaped mass, the long arm of which is 16 cm. in length, the short arm 8½. The greatest width of the kidney is 5.5 cm., the greatest thickness about 3 cm. About 10.5 cm. of the long arm apparently corresponds to the left kidney, while the angle and short arm correspond to the right kidney. The pelvis of the right kidney is directed anteriorly and the calyces are somewhat distended. The pelvis of the left kidney is directed but

slightly anteriorly. Its ureter crosses the kidney mass at about the angle of the L, also crossing one of the calyces of the right pelvis. The upper portion of the kidney received two arterial branches from the aorta, the first arising opposite the superior mesenteric, the second 1 cm. below the first. About 1 cm. below the second is given off a branch from the front of the aorta which is distributed to the extreme right of the short arm of the kidney. About 3 cm. below this branch are given off two branches of the aorta, one from the left side which is distributed to both the long and short arm of the kidney, one branch dividing about the lowermost calyces of the pelvis of the left kidney, the other about the uppermost calyces to correspond to the right pelvis. The second branch given off at this level is distributed to about the central portion of the short arm of the L. The capsule of the left portion of the kidney is thickened and adherent. On removal it leaves a finely granular surface, the projecting granules being light and opaque in color. On section of the organ the cortex is found to be from 4 to 5 mm. in width; its striation is somewhat irregular. The parenchyma is apparently diminished in amount, and here and there are opaque, yellow areas. The lower part of the kidney, the short arm, also has an adherent capsule and its surface is finely granular. The granules appear somewhat further apart and are separated from each other by a translucent firm tissue. The whole organ is much firmer than normal. The small arteries going to the kidney have thickened walls and stand wide open. The ureters are not distended and the bladder seems normal.

Probable Causes of Malformation.—From these extracts it will be seen that a general adjustment has taken place in order to accommodate this anomalous formation. The left anterior horn of the kidney is almost in normal position, but the lower border rests upon the brim of the pelvis and completely covers the body of the fourth lumbar vertebra. This position has crowded to one side the aorta and vena cava, and the spermatic and inferior mesenteric arteries are found coming off at higher levels. The peculiar manner in which the kidneys received their arterial supply is interesting, but it is impossible and impracticable to advance any theories as to the forces which caused them to so deviate from their normal courses. The renal artery to the left pelvis leaves the aorta at a slightly higher level than normally, but otherwise is not unusual. Probably the vessel entered after this portion of the organ had rotated and represents the left renal artery. The next lower artery to this might have been the right renal artery judging from the size and general location, but this is merely surmise. What seems quite plausible, however, in regard to this anomaly is the theory advanced by Pohlman which explains the frequent malformations of these organs, and this present case gives strong evidence to substantiate this theory.

Before presenting this hypothesis, however, it would be well to review briefly the embryonic development of the kidney. It will be sufficient to recall that the kidney arises as a tubular diverticulum from the Wolffian duct near its entrance into the cloaca. These renal buds penetrate the surrounding mesoderm and broaden at their distal ends, forming the renal pelvis while the tubular portion becomes the ureter. Growth continues cephalad until the human embryo has attained a length of 14 mm.[1] (Embryo 144) at which time the rotation begins; the kidneys changing from a dorsal to a lateral position in relation to the ureters. Complete rotation is found at 16 mm.[1] (Embryo Mall 43). The vascularization occurs after this rotation sometime between the stages of 22.0[1] and 24.0[1] mm. At the time that the renal buds appear and for a short time afterwards they lie only fifty microns apart and are separated by a thin layer of mesoderm. According to Pohlman,[2] whose theory has so satisfactorily explained the many renal anomalies recorded by Morris and others, it is this close proximity which accounts for the congenital malformation known as "horse-shoe" kidney. Through some cause unknown the two renal buds come into contact and in their upward growth absolute fusion occurs.

In the present case the upper pole of one and the lower pole of the other touched and the end-to-end fusion occurred at the point represented by the dotted line in the accompanying drawing. From the gross and microscopic structure of the specimen it would appear that the right renal buds had been displaced so far to the left as to touch by both the upper and lower poles the lower poles of the left pelvis. Growth continued till the time when rotation should normally occur, when the fused mass attempted to assume its proper position. The upper pole of the left-hand kidney being freer succeeded in rotating and consequently holds a normal position in relation to its ureter and pelvis.

The remainder of the mass, being more firmly bound and having no axis of rotation, remained in the position in which it had grown from the early embryonic state and still retains the ureter upon its ventral surface. Both ureters have worn deep grooves where they have lain on the cortex and the vertebral column has also made a deep depression.

There is no communication between the pelvis of what was probably the right and left kidneys. The lower part of the mass presents an interesting example of the not uncommon multiple pelves.

[1] These measurements refer to the collection of human embryos belonging to Dr. Mall.

[2] Pohlman, A. G., "A Note on the Developmental Relation of the Kidney and Ureter in Human Embryos." J. H. H. Bull., Vol. XVI, No. 167. Pohlman, A. G., "Concerning the Embryology of Kidney Anomalies." American Medicine, Vol. VII, No. 25.

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A REVIEW OF SOME RECENT WORK ON THE MUSCULATURE OF THE HEART.

By Walter A. Baetjer.

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The difficulty in gaining a clear conception of the development and arrangement of the muscular layers of the heart is readily appreciated in reviewing the literature of the subject. That the descriptions in the text-books of anatomy are confusing is due to the fact that the one article amongst the recent publications on the musculature of the heart which is clear and concise in outlining the arrangement of the layers of cardiac muscle, has not yet been incorporated in any text-book. At the suggestion of Professor Sabin I reviewed the recent literature for the Anatomical Seminar and wrote this brief resumé of the researches of Ludwig, Krehl, Quain, MacCallum, His, Jr., and Retzer, who have made the most valuable contributions to this subject.

Before the publication of Ludwig's article in 1849 little was known regarding the arrangement of the muscular layers of the heart. In this paper, Ludwig states that the fibers on the outer surface run at right angles to those on the inner and between these two there are fibers in regular order showing all the transitions from one direction to the other. The fibers on the outer surface he divides into: (1) those arising in the right ventricle and ending in the left; (2) those arising in the left ventricle and ending in the right; (3) those which begin and end in the right ventricle. The deep muscles arise on the inner circumferences of the openings at the base of the heart and from the papillary muscles.

In 1891, Krehl published a similar work in which he emphasized the existence of a basket of muscle fibers in the left ventricle and at the same time called attention to a band of tendon along the posterior surface of the *conus arteriosus* between it and the aorta. By his discovery of this band of tendon, he was able to distinguish three tendinous points at the base of the heart in which it is possible for fibers to arise, the other two points being the circumferences of the two atrio-ventricular rings as shown in Fig. 1. The fibers of the left ventricle he divides according to their direction and insertion. Under the former classification he distinguishes three layers: the first arising on the upper surface to the right and passing to the lower surface on the left; a thicker one taking the opposite direction; and lastly, a layer of fibers taking an almost spiral course parallel to the long axis of the chamber. He distinguishes two layers according to insertion: the outer and inner ones ending in tendons; and the middle one which, as he expresses it, "ends in itself." The fibers one coming from the left ventricle, the septum, and the aortic of the right ventricle are divided into two layers: an outer ring; and an inner net-like layer. He describes also two other bands of fibers, one of which arising in the upper part of the septum pursues a vertical course downwards in it, while the other belongs entirely to the conus.

Later Quain[1] describes the superficial fibers as composing a distinct layer arising from the tendinous points at the base of the heart and inserted in the left ventricle, chiefly into its anterior and posterior papillary muscles. Those crossing over the front and left side of the heart, he says, can be traced to the posterior papillary muscle, while passing over the back and right side help to form the anterior papillary muscle. Many of the superficial fibers, however, form an inner vertical layer which passes upward to be attached to the tendinous rings at the base of the heart.

The deeper fibers of the left ventricle, composing the thickness of its wall, he describes as arising from the tendinous rings at the base of the heart. From here they all pass obliquely downwards on the anterior and posterior wall toward the apex, where they turn abruptly toward the front of the septum. At this point he divides them into three layers: the first passing obliquely upwards to be attached to the central fibro-cartilage, thus forming V-shaped loops around the lumen of the left ventricle; those fibers composing the second layer pass to the posterior wall of the right ventricle becoming partly continuous with the posterior papillary muscle; the third layer passes nearly horizontally into the posterior wall of the left ventricle and takes an annular course in it. But many of these are continuous with the deeper fibers of the right ventricle.

The right ventricle Quain regards as an appendage of the left, its superficial fibers being continuous with the posterior papillary muscle of the left ventricle and its deeper fibers also passing into continuity with those of the same ventricle. Attached to the right atrio-ventricular ring the anterior fibers of this layer pass backward in the septum to the posterior wall of the left ventricle, while the posterior fibers pass in the opposite direction to its anterior wall. The middle layer enters the lower part of the septum and passes upward to be attached to the central fibro-cartilage. Finally a number of fibers pass directly across the septum and encircle both ventricles.

In these articles we find layers of muscle described as belonging to one ventricle or the other, but in neither is there any mention of the deep layers as being continuous in both ventricles, thus forming the septum in their passage between the two as demonstrated by MacCallum's researches.

The investigations of MacCallum differed essentially from those of his predecessors in that he began his studies with embryonic rather than adult hearts. The tissues were macer-

ated to facilitate the separation of the muscle layers, after which the auricles, in certain of the earlier stages of development, could be lifted away leaving the ventricles.

With the exception of two layers, all the muscles, both superficial and deep, are inserted into the papillary muscles of either the right or left ventricle. Those in the left ventricle are divided into three groups, viz.: a posterior and an anterior papillary muscle and a third group composed of many small muscles, forming the papillary muscles of the septum. A division, similar though less marked, is found in the right ventricle. Here the three groups are attached to the segments of the tricuspid valve.

Superficial Layers.—By their places of origin and insertion, MacCallum shows that the superficial layers can be divided into four groups, all of which arise superficially from one of the tendinous points at the base of the heart and end deeply in the papillary muscles of one of the ventricles. Three of these layers arise from the right side of the base of the heart and pass diagonally around the left ventricle to be inserted into one of its papillary muscles, thus offering an explanation for the greater thickness of its wall. Without exception these superficial layers all pass uninterruptedly across the inter-ventricular line.

(1) The fibers arising from the lower half of the tendon of the conus (Fig. 2, *B*) pass around the right ventricle to the ventral side of the heart, then, taking a diagonal course, they cross the inter-ventricular line passing downwards around the apex of the left ventricle where they turn up and in to be inserted into the anterior papillary muscle of the left ventricle.

Course.—From the posterior half of the tendon of the conus in the right ventricle to the anterior papillary muscle of the left ventricle, as shown in Fig. 2, *B*.

(2) The layer originating in the anterior half of the tendon (Fig. 3) passes upward around the conus to the ventral surface of the heart. From here it runs downward toward the apex just above the preceding muscle, where, after almost completely encircling both ventricles, it turns up and in from the ventral surface to be inserted into the papillary muscles of the septum in the left ventricle and to a slight extent into its posterior papillary muscle.

Course.—From the anterior half of the tendon of the conus in the right ventricle to the papillary muscles of the septum and posterior papillary muscle of the left ventricle, as MacCallum has shown in Fig. 3.

(3) The strands of muscle arising from the right auriculo-ventricular ring take a diagonal course around the posterior surface of the right ventricle to its ventral surface where they pass underneath the fibers from the lower half of the tendon, thus ceasing to be superficial. Continuing in their diagonal course underneath this layer, they cross the inter-ventricular line and wind about the apex to be inserted into the posterior papillary muscle of the left ventricle.

Course.—From the right auriculo-ventricular ring to the posterior papillary muscle of the left ventricle.

(4) The fibers arising in the left auriculo-ventricular ring (Fig. 2, *A*) pass diagonally over the posterior surface of the heart across the posterior inter-ventricular line to the right ventricle where the deepest fibers of this layer begin to turn into the right ventricle to their insertion in its papillary muscles. This turning in of the deeper fibers is a continuous process all the way around the right ventricle to the anterior inter-ventricular line where the most superficial strands of this layer turn in and end in a similar manner.

Course.—From the left auriculo-ventricular ring to the papillary muscles of the right ventricle.

All these layers have a superficial tendinous origin in one ventricle and a similar deep insertion in the opposite one. There is also a small band of fibers crossing the posterior inter-ventricular line near the base of the heart and attached to the left atrio-ventricular ring.

Deeper Layers.—If the layers just described be removed, it will be seen that the deeper fibers all turn in at the inter-ventricular line as though belonging distinctly to one ventricle or the other, which is in fact the generally accepted view. If, however, the left ventricle be gently unrolled from the right, the fibers from the latter are found to cross in the septum to the opposite surface of the left ventricle where they unite with those of the superficial layers to form the papillary muscles of the left ventricle. This process of unrolling is seen in Fig. 4.

Fig. 1.—The tendinous points at the base of the heart. After Krehl.

These deeper fibers MacCallum divides into three layers according to their insertion in the left ventricle.

(1) The first layer arising most superficially in the right ventricle, *i. e.*, farthest from the lumen (Fig. 5, *A*), runs almost completely around this ventricle and crosses in the septum to the left ventricle where its course is closest to the lumen. It unites with the superficial layer from the right atrio-ventricular ring to form the posterior papillary muscle.

(2) The fibers composing this layer arise closer to the lumen of the right ventricle (Fig. 6, *B*) than the preceding layer where they follow a shorter, though similar, course across the septum to the left ventricle. Here their course is more superficial and longer than the preceding layer, passing about three-quarters of the way around the left ventricle to unite with the superficial fibers from the anterior half of the tendon of the conus to form the papillary muscles of the septum of the left ventricle.

(3) These fibers (Fig. 7, *C*) arise closer to the lumen and have a shorter course in the right ventricle than either of the preceding layers. They follow a parallel course, however, across the septum to the left ventricle where their course is the farthest from the lumen as well as the longest of the three layers. They pass almost entirely around the left ventricle where they unite with the superficial layer from the lower half of the tendon of the conus to form the anterior papillary muscle.

Intermediate Layers.—Besides the muscles just mentioned, MacCallum speaks of two other bands which do not fall in either of the above divisions. Contrary to those just described, these two muscles send no fibers to the papillary

FIG. 9.—Diagram of muscle layer surrounding the aorta and left auriculo-ventricular ring. After MacCallum.

muscles. The first layer (Fig. 8) arising in the right auriculo-ventricular ring, crosses over in the septum to the left ventricle which it completely encircles, and, after again entering the septum, it coils about the deeper layers ending finally in the left auriculo-ventricular.

The other layer seems to belong entirely to the left ventricle. Arising from the posterior border of the auriculo-ventricular ring (Fig. 9) it passes forward and to the left making one complete revolution and is then inserted above the fibers of origin.

In thus describing the musculature of the heart, MacCallum emphasizes the fact that while, in general, this is the arrangement of the fibers, it is impossible to make any abso-

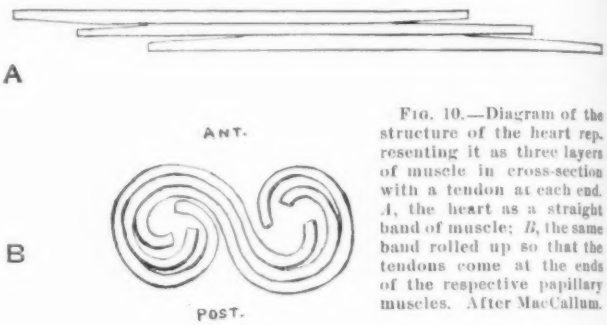

FIG. 10.—Diagram of the structure of the heart representing it as three layers of muscle in cross-section with a tendon at each end. *A*, the heart as a straight band of muscle; *B*, the same band rolled up so that the tendons come at the ends of the respective papillary muscles. After MacCallum.

lute mathematical division between the various layers. Those of the left ventricle, for instance, are separated chiefly by their points of origin and insertion, the division made being mostly for clearness in description.

The simplest conception of the heart can be gained, he suggests, by regarding it as simple band of muscle with three tendons at each end corresponding to the three groups of papillary muscles in each ventricle; and the whole thing wound into a scroll and surrounded by a superficial band of muscle divided into several layers according to their places of origin. In Fig. 10, *A* the heart is seen in cross-section as one band of muscle with three tendinous points at each end. In Fig. 10, *B* this same band is shown rolled up so that the tendinous points assume the relative positions of the papillary muscles of the two ventricles.

MacCallum also noticed that the muscular band comprising the deeper layers of the heart was comparatively thin in the middle and thicker at the two ends, thus indicating that the growth of the walls takes place at these two points. By a microscopic study of the heart in cross-section this was found to be the case. The younger cells, *i. e.*, those with a simple protoplasmic network, are all found close to the lumen of the ventricle.

A further proof of this is the fact that the karyokinetic figures are all seen to be located on the inside of the ventricle close to the lumen.

Conclusions.—The chief things which MacCallum proves regarding the structure of the heart are:

1. The outer wall consists of several layers according to their places of origin and insertion, each of which begins superficially in the tendon of one ventricle and ends deeply in the papillary muscles of the opposite ventricle. The fibers composing these layers all pass uninterruptedly across the inter-ventricular line to the opposite ventricle.

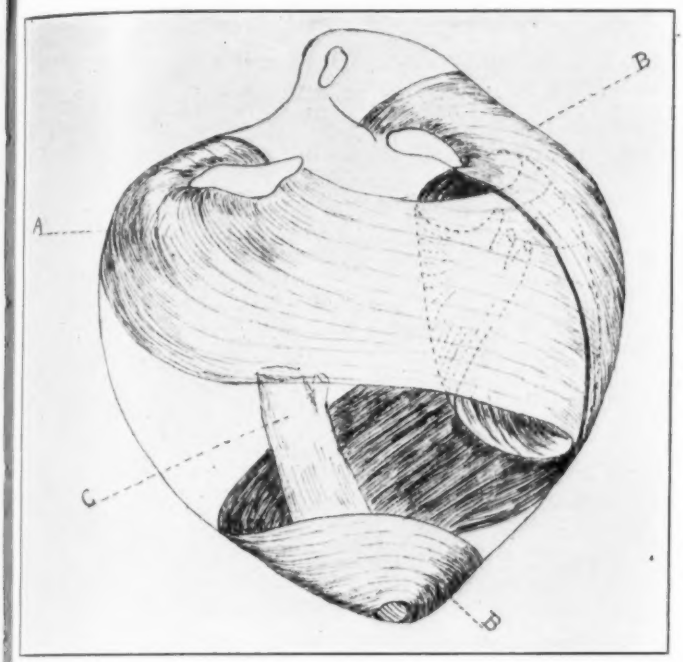

FIG. 2.—Diagram of the course of the superficial muscle layers originating in the left auriculo-ventricular ring and in the posterior half of the tendon of the conus. After MacCallum.

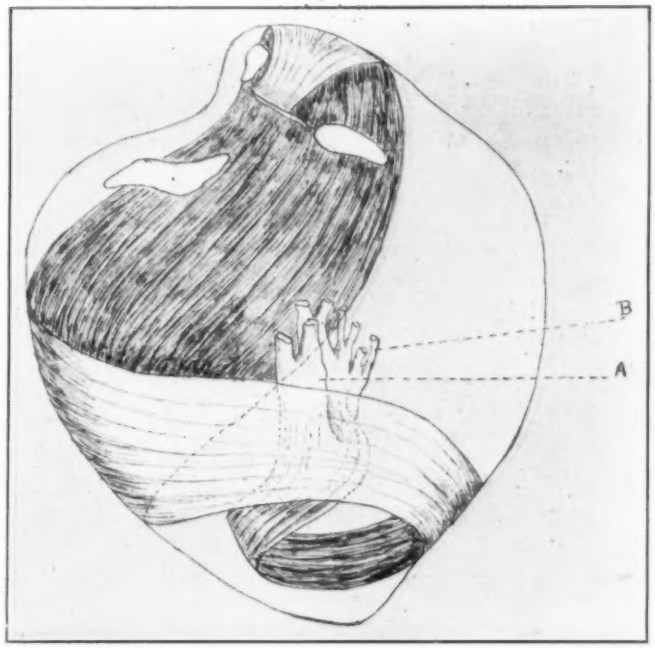

FIG. 3.—Diagram of course of superficial muscle layers originating in the anterior half of the tendon of the conus. *A*, posterior papillary muscle; *B*, papillary muscles of septum. After MacCallum.

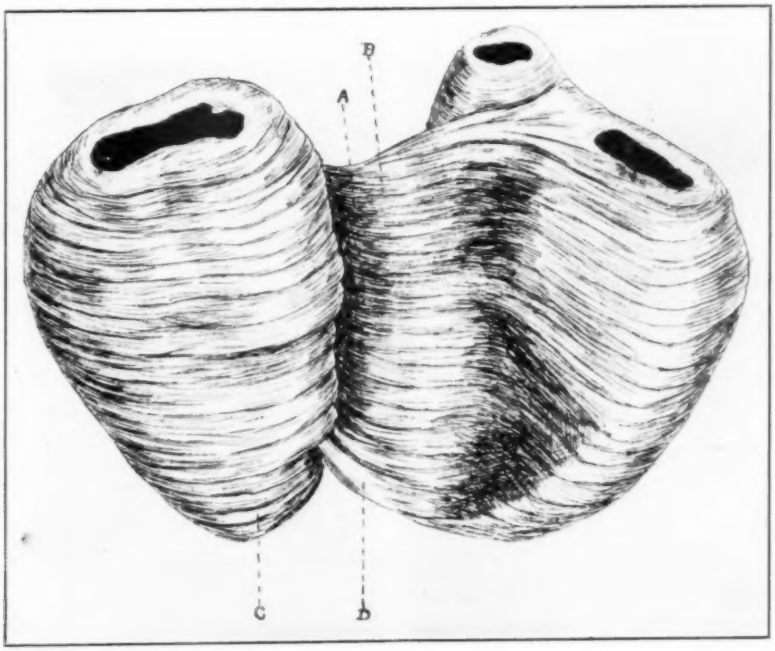

FIG. 4.—Posterior view of the heart showing left ventricle being unrolled from the right. *A* and *B* fibers passing directly from the right ventricle to the left. After MacCallum.

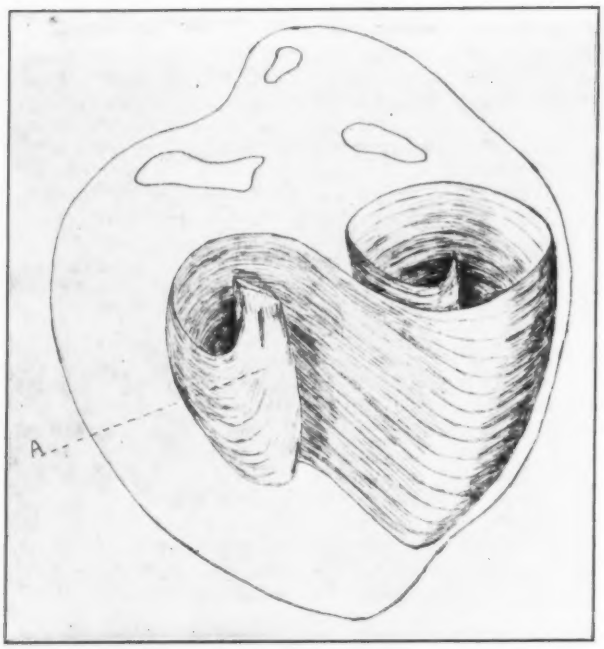

FIG. 5.—Diagram of course of deepest layer of left ventricle: *A*, posterior papillary muscle. After MacCallum.

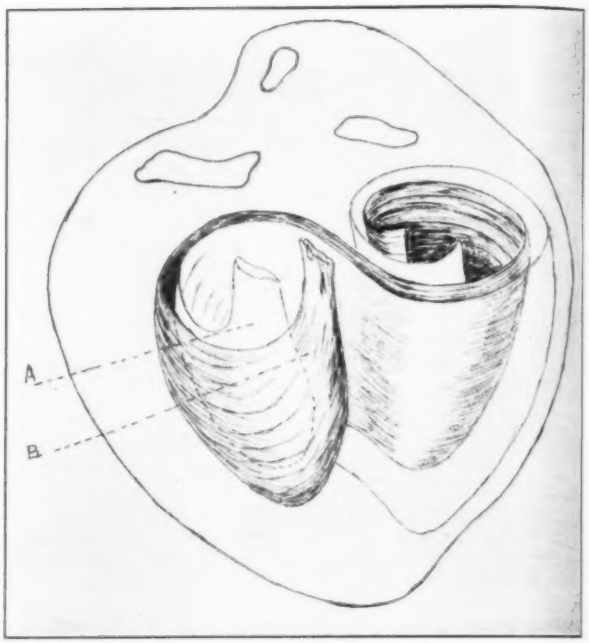

FIG. 6.—Diagram of course of layer superficial to that in Fig. 5. *A*, posterior papillary muscle; *B*, papillary muscle of septum. After MacCallum.

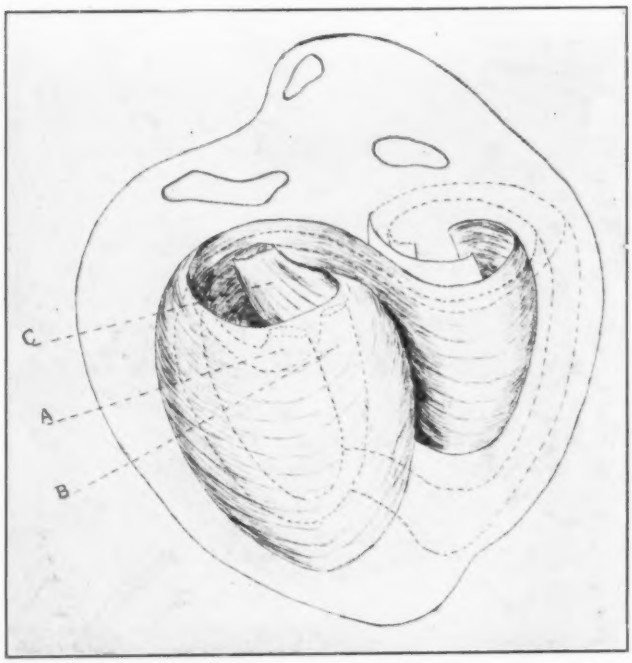

FIG. 7.—Diagram of layer still more superficial, ending in the anterior papillary muscle. *A*, posterior papillary muscle; *B*, papillary muscle of septum; *C*, anterior papillary muscle. After MacCallum.

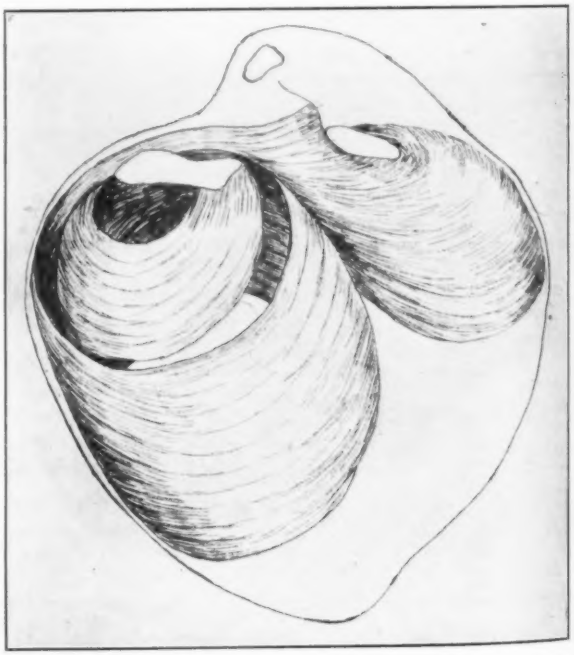

FIG. 8.—Diagram of muscle layer originating in tendon of conus and upper part of right ventricle. This surrounds the layers represented in the left ventricle in Figs. 5, 6, and 7. After MacCallum.

2. The deeper muscles consist of a simple band of fibers divided into three layers, each of which arises in the papillary muscles of one ventricle and takes an S-shaped course to be inserted into a similar structure in the opposite ventricle. Contrary to those forming the superficial layer, these fibers all turn in at the inter-ventricular line passing in the septum, across to the oposite surface of the other ventricle.

The most recent contribution to the anatomy of the heart has been the discovery of an atrio-ventricular band found by His and worked out by Retzer. This is a band of fibers about 18 mm. long which arises from both sides of the inter-ventricular septum. The fibers from the two sides then unite and run backwards over the muscular portion of the septum, to be inserted into the right half of the inter-atrial septum and partly into the mesial leaf of the tricuspid valve.

The importance of the His bundle physiologically has been shown by Erlanger, who has produced heart-block by clamping the bundle.

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NOTES ON NEW BOOKS.

A Manual of Materia Medica and Pharmacology. By DAVID M. R. CULBRETH, PH. G., M. D. Fourth edition. (*Philadelphia and New York: Lea Brothers & Co., 1906.*)

In this, the fourth edition of the work, there has been very thorough revision and in some parts a complete rewriting. Many of the changes have been made necessary by the eighth revision of the Pharmacopeia. To try to review such a book as this in any detail is much like attempting to do the same for a dictionary. As in the consideration of a dictionary, one is chiefly impressed by two things; first, the great number of points which he does not know—by no means an undesirable state of mind for a reviewer—and, second, the tremendous labor involved in collecting and verifying all the information given. This work impresses us as being very carefully done. The drugs are arranged on the principle of associating those which have a common or allied origin. This applies to the vegetable drugs in their botanical relationships and to the organic drugs in their chemical affinities. The doses are given both in the metric and apothecary systems. In addition to the discussion of the pharmacopeial drugs there is a section on certain of the synthetic compounds which are used as remedies. There is an appendix dealing with poisons and their antidotes, and also with weights and measures and prescription-writing.

Reviewing a work on materia medica is very apt to lead to questions as to the usefulness of many of the drugs. The presumption is that somebody employs them, but we wonder, for example, how many men now use stillingia, or how frequently xanthoxylum is called for, or how much of a want would be felt if berberis or phytolacca had been accidentally left out? Doubtless there are men here and there in the profession who are attached to these old drugs but it seems as if many of them might well be dropped. However, to return to Dr. Culbreth's book, we can only repeat the opinion that it seems to be exceedingly carefully prepared and should be especially useful for students of pharmacy as well as for those in medicine.

The Ready Reference Hand-book of Diseases of the Skin. By GEORGE THOMAS JACKSON, M. D. Fifth edition. (*Philadelphia and New York: Lea Brothers & Co., 1905.*)

The feature of this book is the arrangement in alphabetical order of the various diseases of the skin. While this is not scientific it is eminently practical, and that it is popular is shown by the fact that the fifth edition is now in use.

The chapters on anatomy, physiology, diagnosis and treatment are concise yet complete. Under the heading, "Dermatological Don'ts" the author has offered about forty suggestions, which will prove invaluable to the practitioner.

Crocker's classification of skin diseases is the one followed. This is the most practical one in use and opposite each disease gives its prominent feature.

The material of the book is arranged to suit the needs of students, and while not exhaustive, is sufficient for that purpose. The illustrations, however, must be excepted. These are not sufficient for the requirements of a text-book either in variety or in number, and greater care could have been exercised in their selection, though much of the detail may have been lost in the printing.

An appendix contains many formulæ from various sources which should prove useful.

In the endeavor to keep the book abreast of the times new sections on eighteen diseases and eleven illustrations have been added.

Surgical Diseases of the Abdomen. By RICHARD DOUGLAS, M. D. (*Philadelphia: P. Blakiston's Son & Co., 1905.*)

The book comprises 866 pages. The type is sufficiently large and distinct to make the reading very pleasant and easy. There are 20 full-page illustrations, most of which are originals. Those representing kidney lesions are beautifully clear and accurate.

The author states in his preface that it has been his aim to elucidate the difficulties of diagnosis rather than to describe operative technique.

Considerable space is devoted to the consideration of the various surgical diseases of the kidney and of the female genital organs. Some of the latter are discussed at length. For instance, ectopic pregnancy is given 50 pages.

Appendicitis is discussed very fully. In attempting to distinguish various forms of the disease, the author, after making his divisions from a pathologic view-point, gives a separate heading to each and tries to elaborate a distinct train of symptoms. The general effect, however, is not happy, and as a consequence the reader is left with a somewhat confused idea of appendicitis as an entity.

In some chapters, a fuller treatment of the pathology would have been desirable. This is particularly true of the discussion of carcinoma of the stomach. The aut[illegible]'s views in r[illegible]gard to

the predisposing cause of cancer of the stomach are at variance with those so lately insisted upon by Mayo. The statement that ulcer is an unimportant etiological factor will certainly not meet with general acceptance.

The chapter on perforating typhoid ulcer is short but, on the whole, fairly complete.

Pancreatitis is dealt with at some length. The author favors the view of Opie as to its etiology.

Surgical diseases of the kidney occupy 112 pages. In regard to the formation of renal calculus he favors the view that it depends primarily on the presence of an underlying albumenoid cement substance. The section on renal tuberculosis might well have been fuller, but in general the subject is well discussed.

The style is good and in the main clear, but occasionally the meaning is obscure. For instance, in the chapter on cancer of the pancreas, under prognosis, the following occurs: "The course of the disease is progressively downward, and the prognosis absolutely hopeless. Five months after supposed complete extirpation of the pancreas for a large carcinoma, Ruggi's patient was in perfect health." There is to be noticed also an occasional use of unusual words where simpler ones would appear to be preferable, as, for instance, *vespertine* instead of evening temperature.

To sum up, it may be said that the author discusses the various subjects from the standpoint of a study of the literature rather than from his personal experience. A personal imprint and personal views are lacking, and in many chapters, merely the opinions of others are given. Moreover, in some instances, without previous knowledge of the subject, it would be impossible for the reader to decide which view is the one most generally accepted.

On the whole, the book contains a valuable résumé of the subject, but as is the case with most text-books, very little original material.

Progressive Medicine. A Quarterly Digest of Advances, Discoveries, and Improvements in the Medical and Surgical Sciences. Edited by HOBART AMORY HARE, M. D., and H. R. M. LANDIS, M. D. Volume II. (*Philadelphia and New York: Lea Brothers & Co., June, 1905.*)

This volume of Progressive Medicine contains the usual good review of the progress of medicine and surgery during the past year.

Coley reviews the subject of hernia, while Foote takes up abdominal surgery, exclusive of hernia. Both of these articles are interesting and give many valuable references. Coley claims to get better results in operations for inguinal hernia by transplanting the spermatic cord rather than by leaving it *in situ*. He advises against operating for hernia with undescended testis in children before they are 8-10 years of age, unless there is some special indication for operating. It seems surprising that he gives so much space to McArthur's autoplastic method of suture in hernia operations.

The progress of gynæcology is reviewed by Clark, who discusses cancer of the uterus and myoma uteri at some length.

Stengel reviews diseases of the blood, diathetic and metabolic diseases, diseases of the spleen, thyroid gland, and lymphatic system.

Nervous and Mental Diseases. By ARCHIBALD CHURCH, M. D., and FREDERICK PETERSON, M. D. With 338 illustrations. Fourth edition, thoroughly revised. (*Philadelphia, New York, London: W. B. Saunders & Company, Publishers.*)

A previous edition of this work has been reviewed in the BULLETIN and it seems only necessary to refer to the new features of the present edition. The size of the book has been materially increased by the addition of several topics and the insertion of new illustrations. The portion on nervous diseases, written by Dr. Church, presents considerable new matter and many careful revisions. The more noticeable additions relate to nerve regenerations, intermittent limping, herpes zoster, and myoclonus epilepsy.

In the latter portion of the book, prepared by Dr. Peterson, a wholly new chapter appears from the pen of Dr. Adolf Meyer, entitled a "Review of Recent Problems of Psychiatry." It is in fact a complete monograph and contains a carefully prepared, critical, and analytical review of the work of Wernicke, Kraepelin, and Ziehen. The work is discriminatingly done but seems adapted to the requirements of the expert in psychiatry rather than to the "medical student and practitioner" for whom we are told in the preface that the work has been written. The writer points out the excellencies of each of these masters in psychiatry and above all the fact that they make a "conscientious effort to start in the first place from sets of patients and to adapt their descriptions and terms to what they see without any unnecessary regard for traditional classification of words." This is the key-note of their work and the faithfulness with which they have adhered to this ideal is the standard by which the writer estimates the relative value of their work. This chapter is unquestionably the leading feature of the present edition and should be read by every modern student of mental diseases. It is both illuminating and stimulating. The whole work deserves continued praise.

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